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Engineering News-Record

McGraw-Hill Publishing Company, Inc. November 28, 1935 Twenty-five Cents, Five Dollars per Year

Cement being spread on a secondary road in South Carolina in an experimental study of stabilization of road bases under bituminous surfacing

IN THIS ISSUE: Underground Water Storage in Southern California . . . Reinforced Brickwork in Indian Earthquake . . . Design of Concrete Mixes for Mississippi Dams . . . Settlement of Footings in Alluvial Soil . . . The Revival and Present Status of Chemical Precipitation in Sewage Disposal . . . Road-Base Stabilization with Portland Cement

To Young Engineers: Concluding Article of a Series of Recollections by John F. Stevens

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Reemployment Rather Than Dependence

EVERY SO OFTEN someone demonstrates anew how difficult it is to win support for sound industrial principles even from those who should lead public thought and opinion. Each is so harassed by his own immediate problems, so warped by group loyalty, so unfamiliar with fundamentals or so pressed for snap judgments that he is quite unwilling or unable to consider any problem beyond the demands of expediency.

For example, the mayor of a large city recently justified his plea for continuing federal relief by the hoary fallacy that "technological displacement, with labor saving devices in agriculture as well as in industry, * * * means that with a complete recovery of business and industry we will still have several million employable men and women unable to find gainful, permanent employment." Unfortunately this error now is getting wide circulation at the hands of those who are preoccupied with current relief or whose personal interests would be served by perpetuating public relief activities.

This notion that technological progress inevitably implies a continuous and increasing unemployment defies not alone good sense but also the accumulated experience and observation of mankind. Over and over again, our progress has demonstrated that any increase in productivity which achieves a more widespread distribution of goods and services actually generates more employment than it destroys.

IT IS true, of course, that the railroad displaced the stage-coach drivers, the spinning-jenny roused the weavers to fury and the linotype machine played havoc with the hand compositors. But today we have sufficient perspective to see clearly the enormously greater net employment that has resulted from all such "labor-saving" developments. The most casual observer recognizes even now that the consistent saving in the labor required to build an automobile has made possible not only the ownership of some 25,000,000 cars in this country alone but also employment for added millions in service and filling stations, oil wells and refineries, tire factories and dealers, garages and parking lots, hotels, tourist camps and wayside stands. In years to come those who follow us will see just as clearly the new employment inherent in other improvements, now damned and obstructed as tending to curtail employment.

It is quite possible, of course, for special groups, dominated by blind self-interest, to dissipate the gains made possible by technical progress. When organized labor succeeds, through arbitrary legislation in prescribing larger train crews than are necessary, it is doing just that. When capital hogs the fruits of increased productivity through monopoly prices or excessive earnings on inflated capital structures, instead of sharing them with its workers and consumers, it is doing it. When government confiscates through taxation and squanders unproductively the increment earned by our technical progress, it does it. But all this is not the fault of technological progress; it is the fruit of short-sighted self-interest and shameful failure to use wisely the gifts of our scientific and technical endeavor.

AND certainly these diseases will not be cured by soothing our people with the narcotic doctrine that continuing unemployment is inevitable. Once that fallacy is accepted and governmental agencies established to enforce it, we shall find many thousands of employables too easily persuaded that the country—meaning the producers—owes them a living. And then America surely will be on its way to eventual decadence.

Our major problem is not to support unemployed; it is to help fit everyone for reemployment. For every job eliminated by technical progress several are created elsewhere. Once upon a time progress moved so slowly that such dislocations were corrected gradually with but slight distress to the individual; today with a more speedy tempo, we do need some systematic means of readjustment to avoid unnecessary distress. It would be helpful, therefore, if the sociologists, welfare workers and labor leaders would stop swelling production costs by perpetuating unnecessary labor burdens and stop devising new tax burdens to support permanent relief agencies. They might better devote some effort to devising agencies that will help to rehabilitate those whose occupations may be obsoleted by the march of progress and equip them to take new and more productive places in a constantly expanding economy.

Willard Chevalier

ENGINEERING NEWS-RECORD

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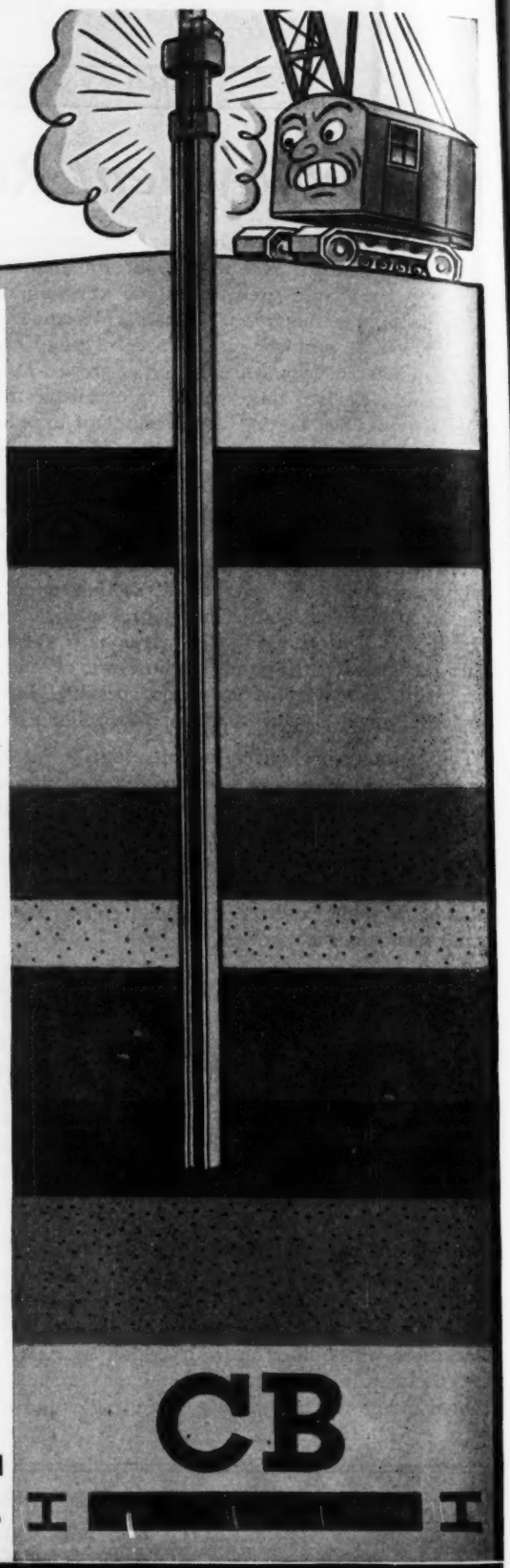

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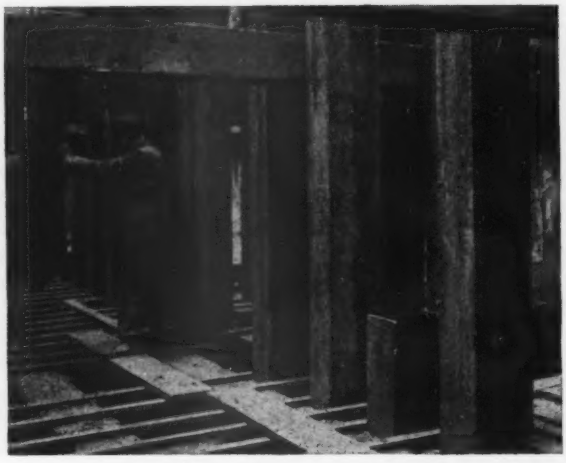

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In the News:

AN ADDITIONAL ALLOTMENT of $900,000 has been made to the Bureau of Reclamation to permit the construction of a high dam at the Cabello site on the Rio Grande in New Mexico. The dam is part of a program of river central being developed by the International Boundary Commission but also will provide storage for irrigation water and power.

ARIZONA has renewed its attack on the apportionment of water under the Colorado River compact. The State has asked the U. S. Supreme Court to permit it to file suit calling for a fair apportionment of the waters.

THE STRINGING OF CABLES on the Golden Gate Bridge has begun.

A COMMITTEE OF ENGINEERS has been named to coordinate the three major power and irrigation projects in Nebraska that have been financed by the PWA to the tune of $40,000,000.

THE WAY HAS BEEN CLEARED for progress toward better sewage disposal at Washington, D.C., by a decision of the district supreme court relating to vaccum filters for which the contract had been held up pending court action.

WITH AN INITIAL ALLOTMENT of $15,000,000, the Resettlement Administration has started to convert 5,000,000 acres of land taken out of agricultural use into forests, recreational areas and wild-life refuges.

CHARGES OF COLLUSION on the part of steel manufacturers in this country growing out of their protest over the purchase of German steel for PWA projects have resulted in a request from the President that the Federal Trade Commission investigate the fairness and reasonableness of certain bids for steel on such projects.

In This Issue:

CONTINUED LOWERING of the watertable in the Los Angeles region in recent years has raised question as to whether the present rate of draft will exhaust this source of water supply upon which the region has depended so largely for its development. The factors bearing on this question are reviewed, the safe yield of all sources is given (including importations), and the effect of imported water is discussed.

REINFORCED BRICKWORK was given its first important test during the Bihar earthquake in India in 1934. Two East Indian engineers made a careful study of the effect of that earthquake on building employing reinforced masonry in their construction, and they give their observations in this issue both as to reinforced brickwork and reinforced concrete and also on some elements of other masonry types.

JOHN F. STEVENS, in the concluding article of his series of recollections, turns from comment on specific happenings in his long career as an engineer to set down his observations as to what characteristics should be developed by young men who seek to succeed in the engineering profession.

RIGID SPECIFICATIONS for concrete used in many dams on the upper Mississippi River resulted in the design of concrete mixes by the use of a remolding apparatus that was found to give distinct advantages over the design of mixes by calculation. Results show that a superior grade of concrete was obtained.

BEARING TESTS made on alluvial soils in the Los Angeles area show wide variations resulting from changes in the size of footings and in moisture content of the soil. Saturation causes a sharp drop in bearing power.

M. N. BAKER, one of the country's foremost students of the history of sanitary engineering, discusses the revival of chemical precipitation in sewage disposal and its significance in relation to the biological process now widely used.

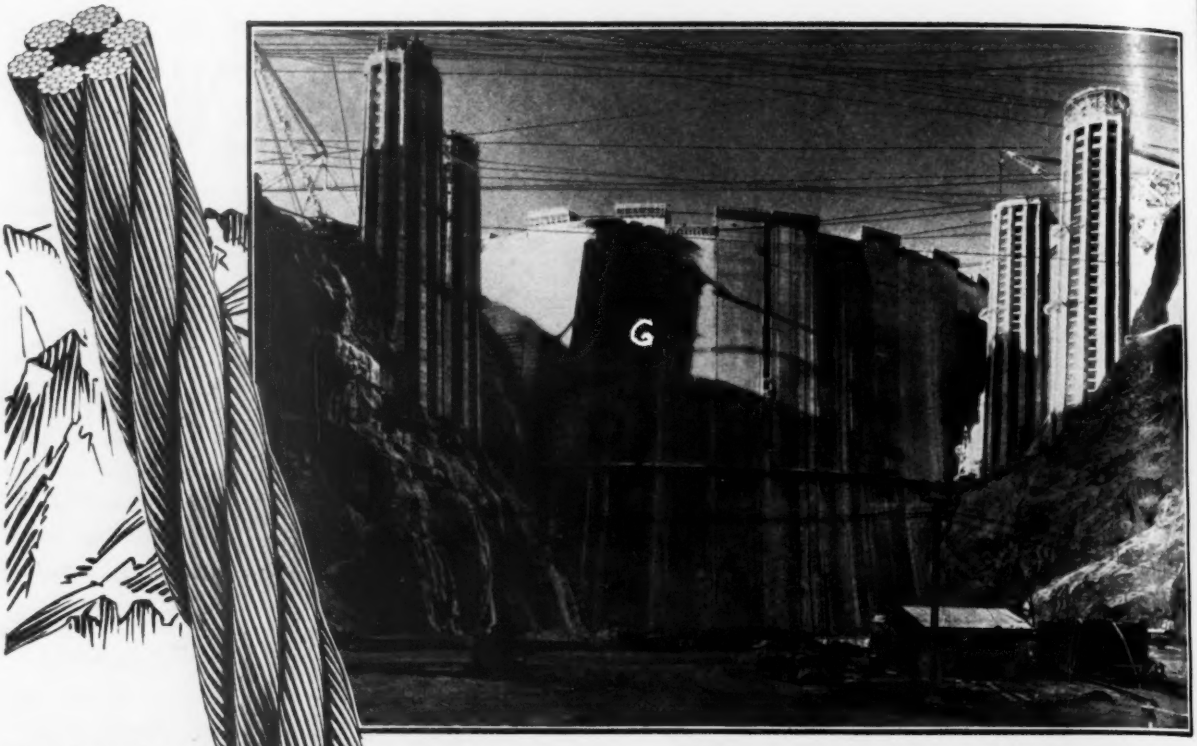
EXPERIMENTS conducted by the state of South Carolina in stabilization of road bases with portland cement preliminary to a bituminous-surface treatment are showing encouraging results. The laboratory methods and field experiments are summarized, and observations as to further studies are given.

SPRINKLING-FILTER REQUIREMENTS of the New Jersey Health Department have been revised to permit over twice the volume per unit of area and depth heretofore authorized.

THE WORKS PROGRAM is far behind the objective set when the Works Progress Administration was set up. The PWA is making a good showing with the reduced amounts made available to it; the lag is chiefly in WPA operations.

Coming Articles:

ENGINEERS of the New Jersey Highway Department have undertaken to separate opposing streams of traffic on one of the state's main trunk roads by jacking pavement slabs horizontally to create a center strip. A description of the work is to be published next week. In addition to its novelty, the operation is an outstanding example of the advantage of careful advance planning and skillful design of special equipment.



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November 28, 1935

Spence Air Photos

FIG. 1—THE APEX of a typical cone is found in the area here shown, the mouth of the San Gabriel River Canyon. The central line across the picture is Foothills Boulevard. It coincides with the location of the fault that separates what is termed Canyon Basin from the main San Gabriel Basin. Immediately downstream from the bridge the watertable is 300 ft. below the surface; immediately upstream it is almost at the surface when the basin is full each year but recedes subsequently.

Underground Water Storage in California's South Coastal Basin

THE rich development of the area which is "Southern California" to most people has been built up on the foundation of the water supply in underground basins. From such basins comes almost 70 per cent of the present supply of California's South Coastal Basin. These underground storages have a combined capacity of about 7,000,000 acre-ft. in the 100-ft. depth below overflow level (only about 60 per cent of this storage has been utilized thus far), and this large quantity of storage is the reason why the basin as a whole has been able to tide over long periods of low rainfall without drastic water shortage becoming evident to most consumers. Exhaustive investigational work done on these underground basins and some of the conclusions which logically follow are discussed in this article. A brief description of the basin is given as introductory background.

The South Coastal Basin comprises the Los Angeles metropolitan area and the rich territory to the east, agricultural in the main but including 26 incorporated cities. For a distance of 90 miles the basin faces the Pacific Ocean; it is cut off from the desert, which reaches hundreds of miles to the east and to the north, by what is referred to in this article as the dominant mountain range—a range that parallels the ocean shore at a distance of 50 miles and has peaks rising to extreme heights exceeding 10,000 ft. Because of this range the climate of South Coastal Basin is more moderate than that of the desert, but even so the summers are long, warm and rainless, such precipitation as there is occurring mainly in the four winter months, December to March.

The main portion of the mountain runoff comes almost at the same time as the rains and rapidly diminishes as summer advances, but irrigation of all agricultural products is required throughout the long summer, in which season stream discharge is almost negligible. In extremely dry years citrus trees and others that have no dormant

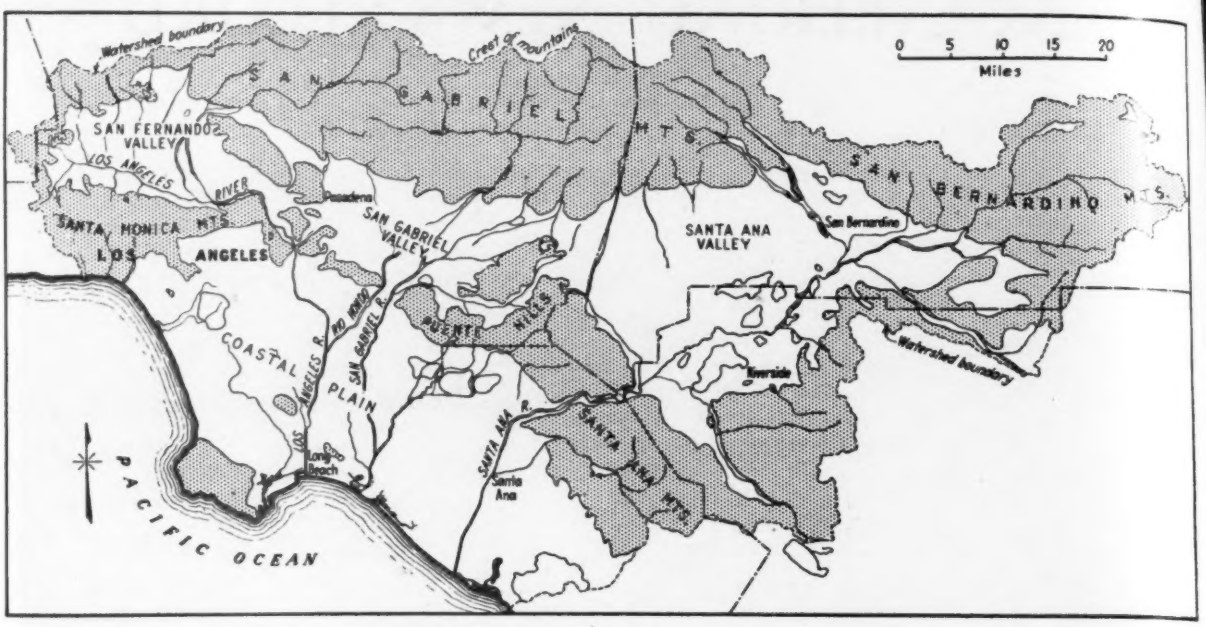


FIG. 2—MAP of South Coastal Basin of California. The shading indicates hilly or mountainous areas.

season may have to be irrigated even during the winter. An annual average of about 1.5 acre-ft. per acre is required for urban use and somewhat more for agricultural use. Domestic use, expressed in other units, averages a little over 100 gal. per capita per day, but in some of the wealthier communities it is at four times that rate.

Precipitation varies widely from year to year. Mountain runoff in the wettest year yet measured was about 40 times that in the driest year. There is practically no safe yield from streams without storage, but this the underground reservoirs furnish. The wide sandy streambeds are normally dry, and into them percolates all the discharge from the mountains except when the occasional heavy rains produce wild flashy floods that push their way across the absorptive valleys to the ocean. In the long time average, however, the water lost from the mountains in these flashy floods is only about one-sixth their total discharge.

For the 58-year period of rainfall record the 4,200 square miles embraced in South Coastal Basin give a safe yield of about 700,000 acre-ft., or about 170 acre-ft. per square mile. In this region about 5 acre-ft. of underground storage space is required for each acre-foot of annual yield—a ratio which indicates the wide variability in supply. There is some historical evidence of abnormally long dry periods during which the yield just mentioned could not be obtained for the entire period.

Population of the South Coastal Basin at the last census was 2,500,000, of which 2,200,000 centered in Los Angeles and satellite cities occupying the western 40 per cent of the area. The general classification of the area is given in Table I.

Despite the high cost of pumping, agriculture competes with the urban communities for water of the underground basins. Growth in both irrigated acreage and population during the last two census decades has been rapid, and the draft on underground basins has increased correspondingly. Coupled with this has been a cycle of deficient precipitation which began with the winter of 1916-17. Either of these would cause the watertable to fall, and their incidence has accelerated the drop. This is ample cause for alarm. Twenty years ago the city of Los Angeles found its local supplies insufficient and built an aqueduct across the desert and through mountains 240 miles northward to Owens Valley. This is now being extended 100 miles farther north (to Mono Basin) to tap a new supply. The Metropolitan Water District of Southern California is building an aqueduct 242 miles eastward, across desert and through mountains, to the Colorado River.

Total supplies to be available to the basin when work now under way is completed to capacity will be about 1,900,000 acre-ft., from sources listed in Table II.

Although the Colorado River water to be imported does not legally belong to the entire region but only to the units of the Metropolitan Water District of Southern California, it is potentially available to a sufficient part of the area to exhaust it, either through the addition of new units to the district or the expansion of present units. In addition, as the district's system will cover almost the entire region, the surplus may be sold where wanted under temporary contracts until needed by the district. At present, ownership is somewhat heavily concentrated in the western end or Los Angeles metropolitan area because of the fact that most of the present district members are in that area. (The so-called Los Angeles metropolitan area is a somewhat vaguely defined area in the western end of the basin containing unincorporated territory and 31 cities. The Metropolitan Water District of Southern California is an aggregation of thirteen cities, of which ten, including Los Angeles, are in the Los Angeles metropolitan area.)

TABLE I—GENERAL CLASSIFICATION OF THE SOUTH COASTAL BASIN AREA

	Sq. Mi.
Total area	4,200
Precipitous mountains (the desert screen)	2,000
Area considered habitable	2,200
Valley lands	1,700
Hills and foothills, mostly unoccupied	500
Occupied area with underground storages beneath	1,200
Area devoted to agriculture.... (High-value crops: walnuts, avocados, citrus)	760
Area in urban development	440

TABLE II—SAFE YIELD OF WATER SOURCES FOR SOUTH COASTAL BASIN

	Acre-Ft.	Acre-Ft.
Local (mostly underground)—slightly more than	700,000	
Owens Valley, at present—slightly less than	200,000	
Present supply		900,000
Mono Basin—slightly less than		100,000
Colorado River Aqueduct (first unit)		450,000
Total available soon		1,450,000
Colorado River Aqueduct (added later)		450,000
Total with aqueducts completed		1,900,000

The problem of water supply to the region as a whole will not be solved entirely by construction of the aqueducts. But whatever is done in the future toward more even distribution of the supply, the underground basins will remain, as they are now, the most important primary sources for most water users. As adjuncts to imported water they still will fulfill a highly important function. They must be more intelligently used than in the past, but the investigational work which has been done indicates that this is possible. Certain unique features of the situation are pointed out in the following.

The basins

South Coastal Basin is traversed by three ranges of hills and mountains all more or less paralleling the ocean. The outer range fronts on the ocean in part and is insignificant; the intermediate range unevenly divides the area between the dominant back range and the outer range. The ranges and the valleys between are products of block faulting, and the valleys are filled with coarse detritus from the mountains. It is on this valley fill of great and mostly unknown depth that the development of the region has taken place. Los Angeles, San Gabriel and Santa Ana Rivers are the major streams. The source of each is the dominant back range; each flows into separate interior valleys back of the intermediate range, gathers its tributaries and discharges through wide canyons or passes in the intermediate range to debouch on the coastal plain and flow across it to the ocean.

The major underground basins are the three interior valleys and the coastal plain. In general, their boundaries are well defined. But the complex faulting of the region and other geological phenomena give rise to further subdivision within each major area. Altogether there are 37 more or less distinctly delimited basins or sub-basins, the boundaries of which, except as to the boundaries of the major subdivisions just mentioned, are seldom evident on the surface; where they do show above ground they are not prominent features of the landscape. They are more often evidenced by sudden and great changes in elevation of watertable and by study of well logs. Some of the sub-basins might be further subdivided by source of water supply. Each basin receives a contribution from those above it either as rising water or underflow, the whole being somewhat analogous to a series of vast pools spilling their contents on the lower side.

The surface slope of the interior valleys is quite steep, and of the coastal plain much less so. The slope of the watertable, of course, is much less than that of the surface. The watertable may be at the surface at the lower side of a basin, but at the upper side in many basins it is 200 to 300 ft. (and in some even 400 ft.) below. Absorption of water from the streams flowing on their detrital cones and deep penetration of precipitation on the valley floors are the sources of the underground supply.

The safe yield of an underground source may become known by long-continued uniform draft coupled with observations of watertable elevation, but no such experience is available for South Coastal Basin. Draft has been increasing rapidly, and to complicate the matter cyclic variation of precipitation causes a large corresponding rise and fall in watertable elevation over long periods of years regardless of draft. The seasonal changes are large and variable with observed maximums of as much as 90 ft. in some of the smaller basins. The watertable reached a high elevation in the year 1916, which culminated a long period of wet years. Since then precipitation in most years has been deficient, and drop in watertable in some small basins from which exportations are heavy has been as much as 300 ft. These are extreme cases, but in the entire San Gabriel valley (which is fairly representative) the average recession in that period of years has been 60 ft.

Without doubt in some basins, notably those in the extreme eastern and western parts of the coastal plain and certain of those near the dominant mountains, the recession indicates permanent overdraft. In others it is temporary and is only an evidence of necessary readjustment of the watertable to the greater draft imposed upon it coupled with the deficient recharge of the current period. Periods of observation of water levels by themselves have not been long enough to be determinative, and exigencies of the situation and the lack of control on draft make it impossible to wait to secure the information in that way.

Investigational work

Investigational work has followed three different lines, all related to the foregoing.

1. The cost and value of water for use in irrigation in South Coastal Basin. The amount of the irrigated and irrigable area well suited and poorly suited to production of the high-priced crops possible to the region which alone can be profitable in most of it.

2. The quality of the underground water. Its impregnation with salts from the soil as it is used and re-used on its journey from the mountains to the sea. The amount of drainage and waste into the ocean required so that the water will not become toxic in an agricultural sense.

3. The supply to, draft on and storage capacity, within feasible pumping lift, of each of the 37 basins heretofore mentioned.

Discussion of the first two is somewhat outside the scope of this article, but the probabilities are that net future agricultural expansion in the basin will not be large and that the amount of dissolved solids in either local, Owens Valley or Colorado River waters is not sufficient to be toxic to agricultural products of the basin. However, the water is used and re-used many times in its slow progress underground to the sea, and its salt content increases, although at present not to a dangerous point. As the natural flushing into the ocean has almost ceased because of lowered watertable, it may become necessary to waste a certain amount by artificial drainage to keep salt concentration in the pumping strata below toxic limits.

Basins resemble surface reservoirs

A large part of the investigation has been devoted to the third item noted above—*i.e.*, the capacity of each of the 37 underground basins and comparison of supply to and demand on each. These basins are somewhat analogous to surface reservoirs. The analogy is fairly definite in some and more obscure in others, but it is sufficient in all so that approach to the matter can be made in the same way as (but less definitely than) the approach to a study of operation of a surface reservoir. Ordinarily the supplies to a surface reservoir are easily determinable, and the major draft on it is controllable. The supply to an underground reservoir in South Coastal Basin, on the other hand, comprises all or most of the items in Table III (depending on the individual basin) only a few of which can be directly evaluated.

TABLE III—ITEMS OF SUPPLY AND DEMAND FOR UNDERGROUND BASINS

Supply:
1. Percolation from streams crossing basin
2. Percolation of precipitation on lands overlying basin
3. Importations from other basins
   a. Sewage outfalls
   b. For direct use
4. Underflow from basin next above

Demand:
1. Use by cultivated crops
   a. Consumptive use in non-artisian areas
   b. Pumpage in artesian areas
2. Urban use
3. Use by native water-loving vegetation in areas of high watertable at lower side of basin
4. Exportations to other basins
   a. Sewage
   b. For direct use
5. Discharge of underground water to next basin below
   a. Surface streams of rising water
   b. Underflow

To evaluate these items requires complete determination of all water arriving at a basin whether in the form of streamflow or precipitation and a complete accounting of the disposal of all of it. To accomplish this requires evaluation of the storage capacity underground. This alone was the subject of an exhaustive special investigation to be outlined later in this article. The collection of routine data necessary to solution of any such problem is noteworthy in this case only because of the large number of well, stream and rain-

fall measurements found necessary. To get at certain other items in this equation, it was necessary to pursue detailed investigations on: (1) consumptive use of both irrigation water and precipitation; (2) penetration of rainfall to the watertable; and (3) water consumed in moist areas by evaporation and by water-loving plants.

An important point that these investigations disclosed is that the heavy desert-type brush growing in parts of the valley having the greatest rainfall consumes about 19 in. of rainfall per annum, while a citrus grove consumes only about 24 in. of combined rainfall and irrigation water. This indicates that these particular areas can be placed under cultivation or devoted to urban use without much net increase in consumption of water.

Underground storage capacity

Evaluation of underground storage capacity is accomplished by determination of the specific yield, *i.e.*, the drainable voids in the valley fill between any two levels. Hitherto some determinations have been made by field methods —that is, unwatering a portion of valley fill and, from measurement of volume of water and volume of unwatered material, calculating the percentage of drainable voids. Because of its comparative simplicity such a method is desirable provided enough determinations can be made at different levels and in different areas, but in South Coastal Basin the variable conditions and many other uncertainties made this method inapplicable.

The approach in this investigation was made by laboratory methods and by developing means whereby results would apply to the material in place. Specific yield is an important matter in any groundwater study and is beginning to receive considerable attention at the present time for use in groundwater hydrology. However, the technique of determination has not been well developed, and probably variations must be made to suit the individual area or basin. In view of this, a brief description is given of the underlying factors that led to adoption of the methods used.

The sediments of South Coastal Basin are generally very coarse and are deposited as alluvial cones that have been laid down by the same intermittent streams which still bring debris from the steep mountain canyons and spread it upon the cone surfaces. The small streams have a steeper gradient in their mountain reaches than do the large streams and hence lay down steeper and shorter cones. The material at the head of the small cones is coarser than that at the head of those of the larger streams because of the greater velocity of the smaller streams. For instance, the median length of the ten largest boulders at the head of a stream that has a drainage area of 47.9 sq.mi. is 7.25 ft., while the ten largest at the head of the cone of a smaller stream that has a drainage area of 3.4 sq.mi. have a median length of 13.1 ft. This inverse variation with size of watershed is consistent on all cones examined. Decrease in size of particles with distance from the canyon mouth follows the typical pattern, but the parent material contains very little clay, and thus little is found in the unaltered deposits.

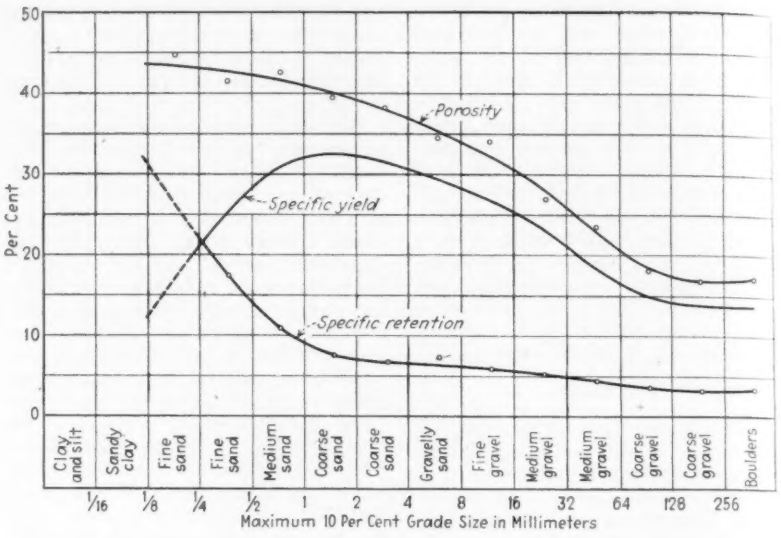


FIG. 3—CURVES showing porosity, specific retention and specific yield for sediments found in the South Coastal Basin.

As previously stated, the watertable is distant below the surface in the higher part of each of the basins and approaches the surface at each lower margin. The climate is conducive to rapid (geologically speaking) weathering of the deposits while they are above the watertable. The watertable must have gradually raised in past ages as thickness of deposits increased; consequently, unless the basin is fairly flat so that the deposits have been beneath water most of the time since first laid down, extreme weathering is found far below present watertable and even to bedrock in the shallower and steeper basins. The end product of weathering is a gritty clay with negligible water-yielding qualities but with about the same porosity as the original gravel or sand.

The small streams have a tendency to entrench themselves in their cones, leaving the remainder of the cone undisturbed, particularly near their apexes, and thus greater opportunity for weathering is given and the weathered material remains in place. Consequently the logs of wells on the upper part of the cones of these streams show a large quantity of clay—sometimes as much as 75 per cent—while in the distal portions the percentage is comparatively small. This is an interesting contrast to the lithologic description of the typical cone where the maximum amount of clay is found on its distal portions.

As contrasted with the cones of the small streams, those of the larger streams are relatively free from clay; that of San Gabriel River contains only 15 per cent. A greater portion of the material has been under water at all times, which delays oxidation. In addition, the larger streams have wandered from their courses more frequently, tending to carry the fine material, whether deposited in place or the product of weathering, to the coastal plain. After deposition of the original material there is a tendency to compaction as new material is superimposed and as the fine materials move downward.

The several principal factors that are general guides to the porosity of the material in South Coastal Basin can be deduced from the foregoing and are as follows:

1. The size of the stream from which it was deposited.
2. The distance from the apex of the cone.
3. The degree of weathering.
4. The depth beneath the surface (compaction).

The attempt at determination of specific yield is predicated on these factors.

Specific yield and specific retention

Specific yield is the difference between the void space or porosity of a granular mass and the specific retention, *i.e.*, the water retained by each particle of the mass due to cohesion, which varies directly with the surface area of particles. The curve of specific yield on Fig. 3 is calculated by subtracting the values given by the curve of

specific retention from the values given by the curve of porosity. If extended, the latter two curves would intercept at about 44 per cent in the clay and silt section of the chart, and the specific yield curve would intercept the zero line.

Classification of materials

The "maximum 10 per cent grade size" at the bottom of Fig. 3 is a term used for convenience and simply means that 10 per cent by weight of the sample analyzed consists of particles with diameters as great or greater than that size, and 90 per cent consists of particles smaller. The presence of large particles in South Coastal Basin sediments indicates a better grading and therefore smaller porosity. The space between the large particles (gravel, boulders, etc.) is filled with the finer materials, and as the large particles contain no voids the porosity becomes smaller as the maximum size of particles increase. Specific retention, however, changes very little with change in size of maximum particles until the coarsest material in the sample is in the order of about a millimeter in diameter. Hence Fig. 3 shows porosity increasing rapidly as the maximum sizes in the samples decrease but retention increasing only slightly until the maximum 10 per cent of the sample becomes as small as medium sand, after which with increasing fineness specific retention increases rapidly.

The "maximum 10 per cent grade size" was chosen as the criterion because the larger sizes are readily identifiable in the field, and therefore this criterion should be more useful than any other. However, several other criteria could have been chosen.

Available underground storage

The 7,000,000-acre-ft. underground storage capacity mentioned previously may be considered the capacity reasonably available for operation, although for periods of a few years this might be increased by drawing down the watertable more than the 100 ft. mentioned. On Jan. 1, 1933, there were 3,500,000 acre-ft. in reserve above an average level of 50 ft. below the watertable of that date, and since then the watertable has lowered still more. The total surface area of the basins is 1,305 square miles, and the average specific yield is 8.4 per cent of the volume, but the variation is between wide limits. For areas of considerable magnitude the maximum is 22 per cent and the minimum 4 per cent.

Conclusions

Outstanding points which logically may be deduced from the foregoing and from other data developed in the investigation are as follows:

1. The efficiency of the underground basins in making available the erratic local water supplies is seen to be remarkable when it is considered that they conserve and hold over for long periods of years without evaporation loss, 80 per cent of the inflow. Without these basins the development of the region would have been a mere fraction of what it is. Surface reservoir sites in the wide canyons of the precipitous mountains are extremely expensive and far beyond the reach of the small community that could have existed on the natural streamflow from the mountains.

2. The most efficient use of the basins has been prevented by legal and financial considerations. In fact it has not been consciously attempted. There is great diversity in the relative supply to and demand on the individual basins. Exportations of water are heavy from the small basins fringing the mountains which, lying at higher elevations, have been drawn upon for the basins below, although in the lower basins there may be plentiful supplies of water. In the preceding discussion the area has been treated as a whole, but as a matter of fact some basins cannot sustain the present draft indefinitely, while others have a surplus.

3. Each acre of land now irrigated and each city can produce water from the underground supply at a certain cost. The cost varies from approxi- by just this much and hence will benefit, without cost to them, all others dependent upon this same underground basin or upon any of the chain of basins below. The watertable will rise, and their supply will be more dependable. Equitable distribution of costs thus becomes difficult, although it could be more closely approached if the various water users (where it is logical to do so) united in districts.

5. The local water must be used regardless of imported water, or it must be disposed of in some other way. Otherwise the watertable would rise so high as to jeopardize present development in the low-lying parts of many of the upper basins and a large part of the coastal plain. This may not be evident so long as the dry cycle of years continues but would rapidly become apparent after a few wet years.

By way of explanation of the foregoing it may be said that before development of the area the supply to the underground basins was balanced by natural waste, largely by evaporation. Several hundred square miles of evaporating area may have existed in the coastal plain and in upper basins. Subsequently this balance was upset by pumping draft, and the watertables have been dropping for a long time, thus drying these areas and freeing them for development. New supplies, if they exceed overdraft, will tend to raise the watertables. Evidently there is some relation between use of imported water and use of underground water which must not be exceeded lest large expenditure for drainage become necessary. In the Los Angeles area, which has used imported water for a long

FIG. 4—SAN GABRIEL VALLEY looking north across walnut and citrus orchards. A typical valley and underground basin. San Gabriel Mountains, the dominant range (a desert screen) in background, Puente Hills in the foreground.

mately $1 to $15 per acre-ft. in different areas of the basin (distribution not included). Local water will compete with imported water in all the 37 basins regardless of overdraft on any one of them, and each individual will use the source which to him is the cheapest after taking into consideration any intangible values such as may exist in an assured supply at a definite price.

4. If any one entity finds that it can secure imported water cheaper than by pumping and does so, this will discontinue draft on the underground supply

time, disposal is made by sewage outfalls into the ocean, a method not available in agricultural uses.

6. Use of imported water on lands in the basin now undeveloped will increase the underground supply, which must be used or disposed of, by much more than the deep percolation usual from irrigation in certain parts of the basin. The desert-type brush in the areas of greater rainfall holds a very large part of each winter rain in its 15- to 20-ft. root zone, but when urban development or citrus groves with shallow root zones replace this, a much greater part of the winter rains will reach the watertable. The underground supply thus will be increased. This will be true also in areas of light rainfall but to less degree. In an area of 20-in. rainfall the new supply to the underground basin would probably be more than 12 in. deep per year.

7. The two aqueducts (Owens Valley and Colorado River) will make physically available to the region a reasonably full supply of water. This will not automatically settle all water problems. Various technical matters affecting the combined use of an imported surface supply and water from underground basins remain to be worked out, and the lack of unified control makes this especially difficult. These problems merit and doubtless will receive more detailed attention when the additional supplies arrive.

Record of Reinforced Brickwork in Indian Earthquake

Floors, ceilings and lintels were undamaged but in many cases were not tied in to connecting elements—Lack of reinforcement in vertical walls was a major cause of failure

By Mason Vaugh and A. T. Mosher
Agricultural Institute, Allahabad, India

THE BIHAR EARTHQUAKE, felt over 3,000,000 sq.mi. of north India in January, 1934, was one of the notable seismic disturbances of recent times. Building destruction was general and loss of life reached the reported total of 7,200 persons. From an engineering viewpoint the earthquake was notable because the area affected included Patna, where the first successful construction with reinforced brickwork was carried out on a large scale. The authors visited Patna and also the city of Muzaffarpur after the earthquake, and the observations in this article are a result of that trip.

Throughout the area covered by the earthquake considerable numbers of structures have been built using various types of reinforced construction, both brick and concrete. Aside from the low mud-walled, thatched or tiled cottages of the peasants, construction falls into three classes. The largest number of buildings have brick walls laid up in mud mortar or lime mortar, with openings spanned by arches and the roof consisting either of jack arches or wood beams with stone slabs or tiles laid on them and surfaced with 4 in. of lime concrete. Quite a large number have the openings spanned by steel beams or heavy angle iron lintels; also there are roofs with steel beams and T-iron substituted for wood beams. A limited but still considerable number of buildings are made with reinforced floors and in some cases roofs, and with lintels of reinforced beams. Some of the larger government buildings are made with reinforced brick ceilings and tiled roofs. No walls have been reinforced in this area except occasionally a thin partition wall. None of these buildings was built for earthquake resistance, since the area had not been shaken in nearly a hundred years.

FIG. 1—TOWER on top of Assembly Building, Patna. Upper part is reinforced concrete, and lower part is unreinforced brick, which proved too weak under lateral motion of earthquake.

The legislative Assembly Building at Patna, built throughout of reinforced construction, was practically undamaged with the exception of four decorative towers on the corners, which were supported by unreinforced pillars.

The Secretariat, or government office building, in the same compound is a large building two stories high surmounted by a high clock tower in the center. The top of this tower broke off and crashed through the roof at its base. Veranda arches used for architectural effect in the ground story did not fail because the heavy pillars supporting them were tied together at the top by reinforced lintels. The upper floor was a solid slab of reinforced brick. The upper ceilings were of 3-in.-thick reinforced brick slabs supported by the lower chords of the steel roof trusses. Apparently the ceiling slabs were supported entirely on the trusses and not tied into the walls, with the result that in some cases the plaster was cracked loose along the edges of the slabs.

In the High Court Building, the second story was a reinforced slab extending over both the rooms and the veranda, the pillars supporting the latter being tied together by lintels over decorative arches. However, the roof and ceilings were unreinforced and gave the veranda pillars no effiective aid, so that every pillar right around the building was broken off at the floor line, and many were displaced horizontally or left out of plumb. Some of the breaks were horizontal and some downward at about 45 deg., presenting a difficult and dangerous repair problem.

Another place of interest in Patna was the Medical College, located on the bank of the Ganges River. Most of the buildings were damaged since the shaking near the river was especially severe. The most severely damaged building was the nurses' dormitory, a two-story building with rows of rooms

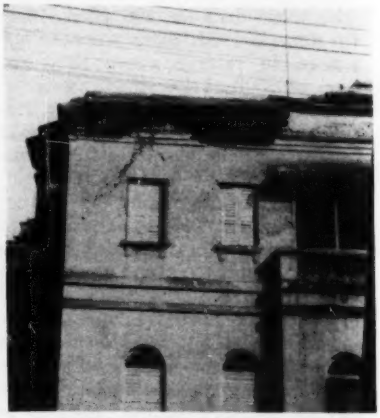


FIG. 2—REINFORCED BRICK roof, undamaged in spite of destruction of a portion of the unreinforced wall that supported it.

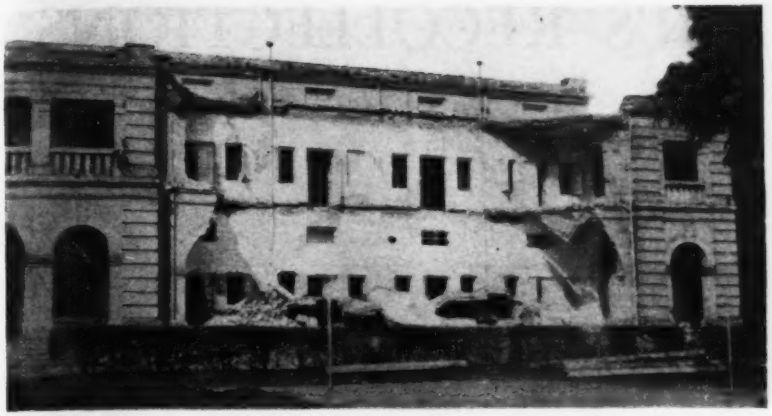


FIG. 3—DAMAGE TO NURSES' HOME, PATNA. Unreinforced walls of veranda arches collapsed, letting reinforced brick floor and roof fold down against walls. In the picture they have been cut loose and are piled on the veranda floor.

FIG. 4—STEEL-BEAM-REINFORCED lintel in Muzaffarpur, pulled away from its supporting pillar during the earthquake.

on both sides of a central hallway and a veranda along the front side. The walls were ordinary brickwork, but the upper floor and roof were reinforced slabs. The walls were badly shattered, with horizontal and diagonal as well as vertical cracks. No slab or lintel in the interior of the building was damaged. The front verandas, except the small end and center entrances, were destroyed (Fig. 3). As far as could be deduced, even here the failure was not in the slabs. Apparently the veranda pillars were thrown outward, leaving the slabs unsupported at their outer edge. The result was that the slabs simply folded down against the walls and hung there. They were later cut away to prevent possible accidents.

In Muzaffarpur the damage to the city as a whole was more severe than in Patna. Here most of the reinforcing was in the form of lintels made with structural shapes rather than with round rods embedded in cement mortar brickwork. Fig. 4 is a view of a new building which suffered severe local damage by serious subsidence and cracking of the ground. The front was heavily reinforced and stood up well, but the part immediately behind was severely shaken up.

Throughout the area buildings constructed with arch construction and using wood roofs were badly damaged. Typical of the damage was that done to the palace of the Maharaja of Darbhanga, shown in Fig. 5.

FIG. 5—WOOD ROOF and unreinforced walls of a large building at Muzaffarpur.

Ordinary brick buildings

The damage to ordinary brick buildings was observed to be generally traceable to one or more of four weaknesses:

1. The outstanding weakness lies in the use of arches especially to support the wall above doors and windows. Designed only for vertical loads, these elements fail when subjected to transverse forces. In other cases, the arches spread under excessive vertical loads until the supporting wall is ruptured.

2. Jack-arch floor and roof construction twists badly under the motion of the earthquake. Lime mortar materially strengthened such construction, but it still appears to be one of the weakest points in the buildings.

3. A third point of weakness exists in the type of construction used for vertical walls and pillars. Vertical walls varied in damage with the type of mortar used more than with any other observed factor.

4. The fourth major weakness in most reinforced buildings lies in not tying the different elements together. This applies particularly to ceilings and walls.

Reinforced masonry buildings

Two major weaknesses were observed in buildings of reinforced brick or concrete. In these buildings the reinforcement is limited to floors, ceilings and roofs and lintels over doors and windows.

1. The greatest weakness rests in the use of unreinforced vertical walls.

2. The second major weakness in such buildings is the lack of integral construction to prevent the separation of floor, wall and ceiling units. Even reinforced work was usually laid on top of walls rather than being built into them.

As this is the first time that reinforced brickwork has been field-tested on a large scale by natural forces, it is interesting to review its results. In general, the better the mortar the better the building withstood the shaking. Units made with mud mortar or with weak lime mortar were seriously damaged in all cases. Where originally good mortar had deteriorated, the same effect appeared. New buildings made with good materials stood better. Both arches and wood lintels were elements of weakness. The superintending engineer of the public works department of Bihar and his executive engineer agreed that the earthquake had made the arch obsolete.

There were no steel-frame buildings in the area, so that no comparison with this type of construction is possible. Reinforced concrete is definitely higher in cost, and there were only a few buildings utilizing this type of construction. Where it was possible to get comparisons, there seemed nothing to choose between reinforced concrete and reinforced brick as regards resistance to earthquake damage.

AN ENGINEER'S RECOLLECTIONS

By JOHN F. STEVENS

Consulting Engineer,
Baltimore, Md.

·XIII·

To the Young Engineers Who Must Carry on

Reflections as to the future of engineering — The young engineer will build his career on native ability, thorough training in fundamentals, common sense and initiative backed by faith and a willingness to work hard

IT IS a justifiable assumption that, as the years roll on and as the future presents its countless complicated problems, the engineer more and more will take his place as a leader in the army of progress, and his will be the brain and his the hand that will solve the most vital of these problems, the correct solution of which will directly affect the happiness and comfort of millions yet to come.

Perhaps I may be pardoned for believing that a few words from one who for a span of two generations of active professional life has seen and who has had a humble share in the development of our marvelous country, may be of value to those young men upon whose shoulders will fall the supreme duty of carrying on.

It is gratifying to the engineers to know that year by year the great importance of their profession is being realized by the general public, that it covers a vast field, in fact enters into almost every field of human endeavor. And with the marvelous advance which the last few years have seen in harnessing the mysterious forces of nature and making them the servants of mankind, an advance that will continue to be made in still greater ratio, so in like manner the field of the engineer will widen, and his place in the sun become more and more conspicuous. But this increase in his field of usefulness will impose still greater responsibilities upon him, and he should early realize that to meet them he must give his every effort to fit himself for the many burdens laid upon him, so that when the account of his stewardship is made up he can go to his appointed place knowing that the world is the better for his having lived.

Technical training needed

There can be no question as to the great value of a technical training as a prelude to a successful engineering career. It is not merely the knowledge of the fundamentals of engineering which the student acquires at school. Of equal value to him is the mental training, the development of his perceptive faculties, which enable him properly to weigh all of the component parts which enter as a mass of detail into every problem that he is called upon to solve, to give each factor its correct value in relation to a complete whole, and thus to arrive at its true solution. The years spent in such preparation are in a great measure the most important of an engineer's professional life. Without the training which they give, one is seriously handicapped in any endeavor to rise to eminence in the profession.

Many times it is said that such and such an one has done well and made a name for himself without the benefit of a technical education. In 100 per cent of the cases cited the statement is not true. Every real engineer must possess in a greater or lesser degree technical training or knowledge. And few of those who comment so glibly upon the lack of necessity for such training at school realize the hard and unremitting study of books and publications and the close observation which the self-educated engineer must pursue during many years, to the neglect of his social and general obligations to the world in which his lot is cast.

I speak feelingly in regard to this matter. Sixty years ago the young man who was then privileged to enjoy the benefits of a technical education was the great exception, and at that earlier period engineering was hardly recognized as a profession; at least it had not to any great extent acquired the high standing that it now enjoys.

IN THIS, the concluding article of the series, Mr. Stevens turns from reminiscence of his experiences in engineering to set down some of his reflections as to the future of engineering and of engineers. From his vast storehouse of knowledge of men he sets forth clearly those things which appear to him to be essential to the young engineers who in his opinion have opening before them still wider fields for pioneer effort than were opened to his generation. —EDITOR.

Handicapped at the start

Starting with no other book education than that afforded by the country common school and a two years' course at a normal school, the latter being supposed to fit me for becoming a teacher in the public schools, it did not take me long to find out what I was up against, when alone and unaided I tried to break into the engineering game. It was like trying to navigate a ship without any knowledge of navigation, when, unless an unusually favorable providence intervened, nothing but a wreck could be expected.

So, being luckily endowed with a bulldog tenacity of purpose, I started to acquire engineering book knowledge at the same time that I was working for a bare livelihood for my family and myself. In this sense I became in a measure self-educated, as I never saw even the outside of a technical school or listened to a technical lecture in my younger days.

I fear that I am laying myself somewhat open to the charge of introducing too much ego into these remarks, and my excuse for doing so is that I want to impress upon the young engineer the fact, and it is an all-controlling fact, that labor, mental as well as physical, is the driving force which will insure success in engineering as it usually will do in all lines of human endeavor.

No royal road to success

And to attain success you must regard your work as of the first importance —materially speaking. There is no royal road to success in the profession, and it is only through intelligent work of preparation and careful attention to details, however unimportant they may seem to the impatient student, that suc-

cess can be hoped for in an engineering career. And this work of preparation never ceases until his last great final estimate is made up, ready to be submitted to the One who plans and executes all things.

So it cannot be too strongly impressed upon you, young men, that unless you are satisfied with just gaining a precarious livelihood, all you need to do will be to regard yourselves as full-fledged engineers once your diplomas are handed you, taking them as evidence that your work of preparation is over and that heavy responsibilities and high salaries will at once be forced upon you. Far from it. Your real work of preparation is only just beginning, and one of its most important features is the acquisition and application of the knowledge of how to adapt yourselves to varying conditions of environment in any situation in which you may find yourselves.

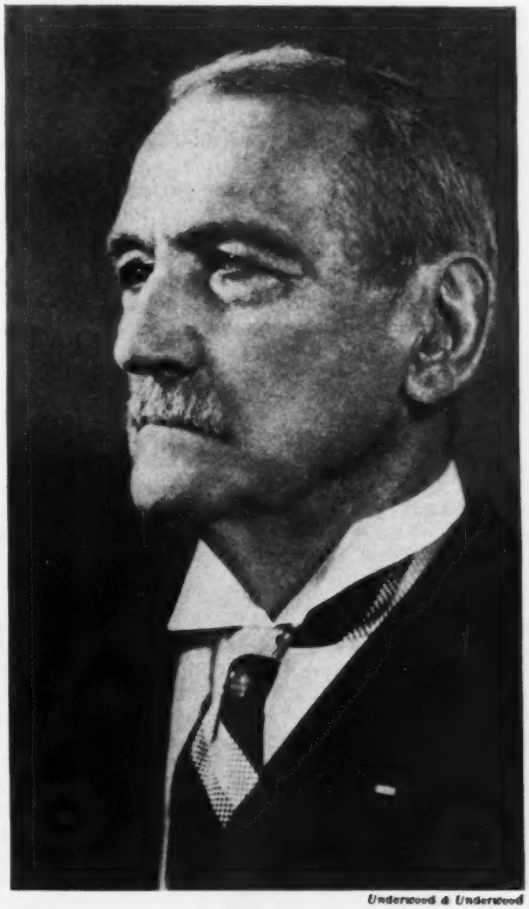
Personality important

And this is where the personality of the engineer is of importance. Recollect that no one knows it all, and that the other man's opinion should be listened to and discussed in a respectful manner, whether one agrees with it or not. Instances are called to mind where engineers, really able from a technical standpoint, have been given scant consideration owing to their inability or unwillingness to afford an opportunity for discussion of any proposals but their own, and they have lost out in consequence.

There is no profession that calls for more self-control and courtesy towards others than that of the engineer. If the engineer is sound in his facts and figures and is sound in his deductions, in the end he will prevail. If he is not, then he does not deserve success, and no amount of bluff will carry him through. The oft-quoted phrase "By their works ye shall know them" might have been spoken especially of the engineer.

Maintain self-respect

One important thing that an engineer should at all times remember and practice is to keep his self-respect; and this he can not do if he allows himself even to tacitly approve plans which in his heart he knows to be wrong. Instances are known where an engineer, for the sake of apparent temporary gain, has not only not protested against faulty plans but has engaged himself to carry them out, on the plea that he was not responsible for them. An engineer is morally responsible for any work that he undertakes to execute, and if he cannot respect himself, no one of consequence will respect him. In effect, an engineer who assumes work under such conditions is taking money under false pretenses in exchange for his honor.



Underwood & Underwood

John F. Stevens

The word "engineering" is a very comprehensive one, of great scope and extensive application, and covers activities whose limits are boundless. And so the engineer, although he may be educated along some special lines, must ever regard himself as something more than a component part of a machine. By reason of his favored position in the realms of science he owes a duty to the world beyond the mere service which he may give in the practice of his purely technical specialty. We are daily confronted with grave problems requiring legislation, and many of these problems, if correctly solved, must be solved by the aid of engineers.

Nothing is insignificant in engineering *per se;* whether it involves small amounts of capital or many millions, it is equally important, to yourself at least, that your every endeavor be given to doing a perfect job. And while in every case you cannot yourself directly carry out the details of your work, you must cultivate enough knowledge of human nature to enable you to select the right assistants and to know that the work entrusted to them is well done. Choose the right men, give them ample authority, and hold them responsible. This is the secret of successful administration, and in the end you will be held responsible. No man can know everything, and no greater failures are recorded than have been occasioned by such assumption.

The point is reiterated that a young engineer must not expect to leap into prominence early in his career, especially through some spectacular performance. True confidence in one's own ability, judgment and character is usually a plant of slow growth, and the reward comes accordingly. An engineer should have high ambition, for without ambition life in any sphere of existence is a dismal failure. But his ambition should be to do as well as possible the work given him, however small it may appear in his eyes, and at the same time to be fitting himself to handle the larger work and to take the place of the man above him whenever ligitimate opportunity shall present itself.

Most of us, and the writer was no exception, had the belief that we, as subordinates, were doing all the work and that our superior officers were getting all the credit and the money. But as we climb higher and higher we realize that higher rank means vastly increased responsibilities as well as greater financial returns, which, of course, is justifiable. And the farther an engineer advances in his profession the more he will realize, if he is a real man, that his success is largely due to the loyalty and good work of his subordinates—which can always be secured by fair treatment, by giving them credit for their good work and not trying to take it all to oneself.

Imagination needed

One endowment, which in a measure is inborn, that a man should possess to become a really great engineer is that of imagination. The layman usually visualizes an engineer as a man whose skull is packed with dry rules and figures and not much else. He may have a most complete set of plans for his proposed work, but unless he can see in his

mind's eye, even before a stake is set, the completed whole, functioning in its perfect way, he cannot enter into the larger spirit of the undertaking; if he cannot do this, he can only expect mediocrity as a result, and mediocrity is one form of slow death. As the Book of Proverbs wisely says: "Where there is no vision, the people perish." Vision is only enlarged imagination.

Seek a broadened outlook

While an engineer should regard his work as of prime importance, he should not neglect to keep himself well informed in regard to current matters in other walks of life. Failure to do this will inevitably make him narrow-minded, and this will make it impossible for him to rise high in his profession, when he, as he must, comes in contact with those men who possess worldwide knowledge and upon whose word may hang his future. Without such knowledge he may be "among them but not of them," and as such will not receive the full consideration to which he might otherwise be entitled by reason of his technical knowledge.

Common sense a sure weapon

In looking back over more than half a century of my own active professional life as well as that of many others whose work has come under my close observation, it seems to me that more successes have been the result of the application of common sense to the problems at issue, and, *per contra*, more failures have resulted from the lack of it, than from any other one cause. No one can define common sense—it probably cannot be defined in words. It is like swallowing—we can all swallow, but none of us can tell just how we do it. Yet common sense is the sure and steadfast old weapon, armed with which the engineer can meet and overthrow the half-baked theories and impracticable schemes that will inevitably confront him. So if the young engineer, by diligent study and more especially by observation, has absorbed and assimilated what his perceptive faculties have given him, and can be content to keep his feet on the ground while his head is in the air, giving always the best that is in him to everything that he undertakes, there is no valid reason why he cannot make a success of his life's work, become an honor to his profession and a blessing to mankind.

It is trite to remark that we are living in an extraordinary age, yet there is truth in that statement that will bear serious thought. The record of the progress that science has made during the past few years reads like a fairy tale; but who is rash enough to predict that science has even more than nibbled at the great feast which nature has in her storehouse? And it is only natural that we, who are passing off the stage of development that we have watched and assisted, should envy those who are to succeed us. With all due respect for what our forebears have done and what we of our generation have done and are doing, I believe that we are but children picking up pebbles on the shore of the boundless ocean of wonder which our eyes have just begun to behold. My faith is strong in the belief that in all branches of engineering, in their broadest application, the necessity for doing more marvelous and vastly greater things than we have heretofore been called upon to do will become more and more pressing.

The engineer of the future

What then should the engineer be? A mere plodder, a copier, one who only follows along the tracks made by his predecessors, perhaps only trying to better their methods somewhat, but in the end producing the same results? If such is to be the description of the engineer of the future, then the hope for the advance of the world along lines which lead to a higher civilization is indeed a faint one. No, the true engineer will be one who, while "holding fast to that which is good," will strike out along new lines and will conceive new ideas which will be translated into the kind of wealth that will bring greater happiness and comfort to mankind.

Have faith

Therefore, a message to the young engineer: Have faith—faith in yourself and faith in the shadowy future; and, in the words of an old German poet, "Go forth to meet it without fear and with a manly heart." Remember that by the sweat of your brow shall you obtain bread. And remember, too, that in the last analysis there is but one perfect rule to follow, one which should guide your professional as well as your every walk in life, "Do unto others as ye would that they should do unto you." If you follow this rule, you cannot go wrong.

You will meet with difficulties, you will at times become discouraged and wonder if it is all worth while. The real man will find a way through or around these difficulties, and the experience that he gains will be worth all the efforts he has put forth to conquer them. Ore is not steel until it has undergone the baptism of fire, and the real test of a man comes when he meets trouble. To quote from Goethe: "It is only when he has to work within limitations that the real master proves himself."

New and broader fields ahead

It is often said that the profession is already overcrowded. The same is said of every profession. But my belief, in view of the advance which science is making at the present time and which is increasing in almost geometric ratio, is that not only will the now exploited fields of engineering widen but new ones will develop. More and more the economic forces of nature, many of which are now lying dormant as far as man is concerned, will be unleased and guided by the engineer along paths which lead to the benefit of the world and to a higher plane of civilization.

The best training

There is no education which better fits one for the duties and responsibilities of life, whether he intends to follow a technical career or not, than a basic knowledge of engineering. It not only puts a man close to nature and gives him a wholesome respect for her laws, which cannot be broken with impunity, but it also trains his mind to weigh carefully every factor that may influence his work in whatever line of endeavor he may engage. "Perfection is made up of trifles, but perfection is no trifle."

I therefore say to the young man who has fully determined upon engineering as his life work to remember that he is joining not only one of the greatest but also one of the oldest of the professions. The cave man who first rolled a stone instead of carrying it or who first threw a log across a stream was as much an engineer in principle as those of us who now design and build our modern works. His was an intelligent effort—instinctive perhaps—which was put forth by man to make nature the handmaiden as well as the beneficient godmother of the human race, the same effort which the engineer of today is making and which is peculiarly his province. The matter of his success lies largely in his own hands; in engineering as in other walks of life, we generally get what we are entitled to. While the rewards are not always in the shape of great material wealth as the world regards wealth, they will come to the engineer in the knowledge that he can leave a good name to posterity, and that he has contributed something to the comfort and happiness of succeeding generations.

A heritage to pass on

And we of the older generation, who must hand over to them the direction of affairs that we have so long regarded as our own, can do so with perfect confidence that the work will be carried on, probably better than we have done it. There are mountain heights yet to be scaled and ocean depths yet to be sounded, and such tasks constitute the greatest heritage which we can leave to those that follow us. And the belief that this heritage will be handed down to succeeding generations in vastly increased value and potency for the spiritual and material welfare of the world makes us feel that our lives have contributed somewhat to the future happiness of mankind.

Design of Concrete Mixes for Mississippi River Dams

Use of remolding apparatus found quick and efficient in crowded work of designing concrete mixes from different aggregates for seven simultaneous operations involving 430,000 cu.yd. of concrete

By Ralph P. Johnson
Assistant Engineer, U. S. Engineers Office, St. Paul, Minn.

FAST PROGRESS in the slackwater navigation improvement of the upper Mississippi River by 26 locks and dams has developed a number of records of interest in concrete placing and control. In the following article an exceptional method is described of designing concrete mixes for five locks and two dams of this season's construction in the St. Paul engineer district. A general account of the navigation plan was published in *Engineering News-Record*, March 8, 1934, and other articles on individual features of the work have been published in the issues of Jan. 25, March 15 and 29, 1934, March 7 and April 14, 1935. Particular interest in the navigation structures lies in roller-gate dam design and construction, concrete-mix design, concrete placing by pumping and vibration, and cofferdam studies, which either have been described or are covered by articles in hand for early publication. —EDITOR.

DURING the 1934 construction season, five locks and two dams, comprising about 430,000 cu.yd. of concrete, were built in the St. Paul Engineer District of the upper Mississippi navigation improvements. All the contracts were let during the fall and winter of 1933-34, and in all cases the completion dates were specified as being during the winter and spring of 1934-35.

Because of the severe winter weather along the upper Mississippi River, concreting was carried on at a rapid pace during the summer months, employing plant and methods that would have been suitable for projects of much greater magnitude.

Concrete requirements rigid

In the fall of 1933, the Corps of Engineers issued a new set of specifications for concrete and concrete aggregates. The objective of this new specification was a concrete of the highest quality in respect to (*a*) resistance to weathering and abrasion (*b*) freedom from cracking (*c*) uniformity, and (*d*) strength.

Resistance to weathering and abrasion was provided for by requiring better curing and the use of vibration in placing. It was expected that cracking would be largely eliminated by reducing the rate of heat evolution as well as the total quantity of heat evolved during the hydration process. To accomplish this purpose, the specifications required that: (1) a coarse-ground cement be used; (2) aggregates must be cooled by sprinkling before being used; (3) the coldest obtainable mixing water must be used; and (4) the cement content must be low, but not less than 4.5 bags per cu.yd. would be permitted. The second and third provisions apply, of course, only to concrete placed during warm weather.

Uniformity of concrete was provided for by requiring: (1) the use of well-graded aggregate; (2) the elimination of segration in coarse aggregate by separation of the material into two sizes when its maximum size was less than 2 in. and into three sizes when its maximum size exceeded 2 in.; and (3) the use of modern batching plants capable of ready adjustment. The concrete was to be relatively dry but of such a consistency that it could be rendered entirely plastic under vibration. Strength was to be obtained by the use of sound aggregates and the lowest practicable water-cement ratio consistent with the requirement of the specifications, which limited the maximum water content to 6.5 gal. per bag of cement.

FIG. 1—REMOLDING DEVICE used in designing concrete mixes for locks and dams of the Mississippi River navigation improvements in the St. Paul Engineer District.

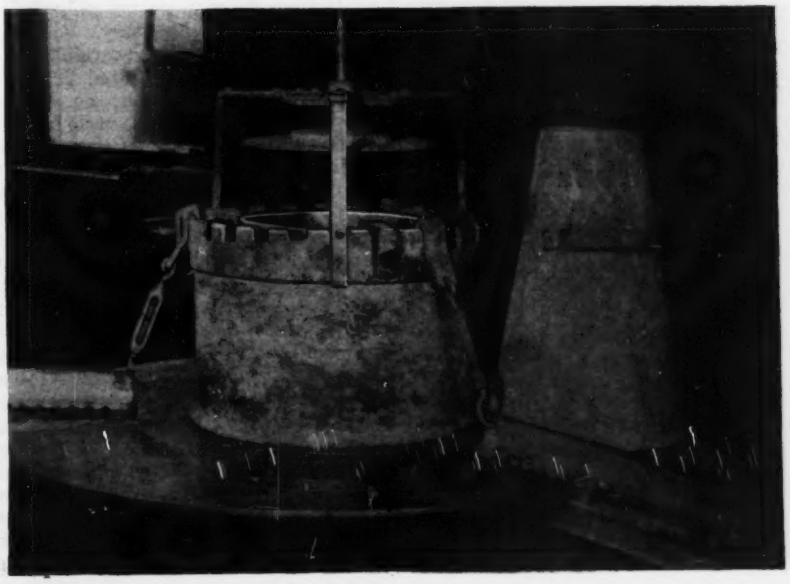
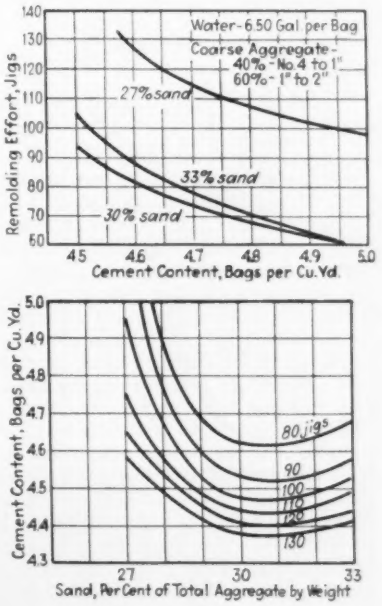


FIG. 2—CHART worked out for each aggregate combination. Similar charts were made for two other water-cement ratios.



Available aggregates

Many sand and gravel deposits are located on the elevated terraces in the river valley. As these deposits are of a glacial origin, they are composed of various types of rock. The majority of these materials are very sound and durable and are suitable for use as concrete aggregate.

In general, the gravel is uniformly graded, and its size ranges upward to about 4 in. The sand was found to be quite well graded and generally satis-

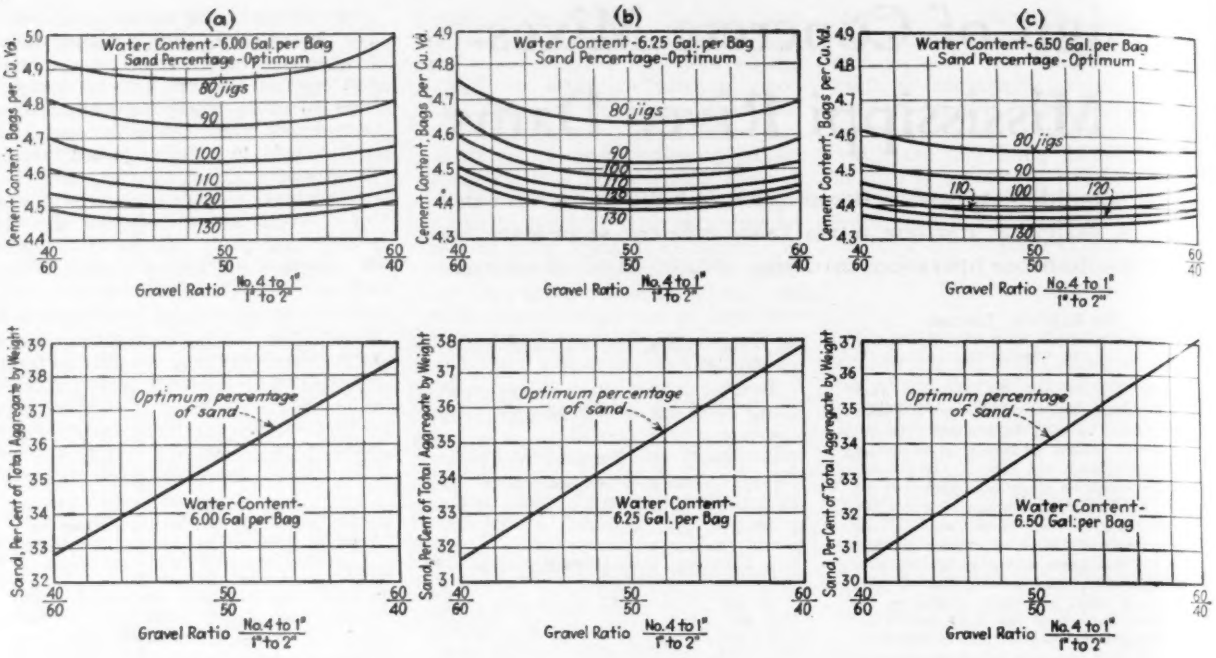


FIG. 3—OPTIMUM SAND PERCENTAGES required for various gravel mixtures and water-cement ratios.

factory, except that there was usually a shortage of the finer particles. This deficiency in fines was corrected by mixing various sands at the pits before the material was washed and by blending with fine sands at the batching plant on the job. Both of these methods gave the desired result, although blending the sands at the batching plant proved more satisfactory because it provided a sand of more uniform grading. Sands were subjected to the briquette test for strength, and the coarse aggregates to the freezing and thawing test for durability.

The prospecting for aggregates and the erection of washing and screening plants were all done during the winter and spring of 1934. Thus, samples having a grading truly representative of the material as it was to be delivered on the jobs were not available until shortly before concreting was actually begun.

Mix design

In selecting a method of designing mixes, several factors had to be taken into consideration. First, the acquisition of aggregate samples at such a late date, coupled with the fact that concreting was to start on most jobs almost simultaneously, made it necessary that the mixes be designed by some rapid method. Second, the design had to be thorough, to permit the use of the minimum cement content allowed under the specifications (4.5 bags per cu.yd.). Third, inasmuch as the grading of the material might vary from that of the samples submitted, it was highly desirable to obtain information which would indicate what changes in proportioning were necessary to offset such variations in grading. To achieve these aims, the remolding apparatus as used by T. C. Powers in studying workability (*Journal*, A.C.I., Vol. 27, 1932, p. 419), was adopted and all mixes were designed by this trial-mix method. Although this method is not as rapid as designing a mix by calculation, it provides advantages in the field which offset the few days' additional time required.

A complete description and discussion of the remolding apparatus (Fig. 1) and its use are given by Mr. Powers in his paper, and only the general principles of it will be explained here. The test itself merely consists of changing the shape of a mass of concrete from that of a cone to that of a disk by jigging on a flow table, and differs from the flow test in that the flow is partly restrained. The number of jigs required to make this change in shape is a relative index of the amount of work required to place the concrete in its final position in the form. Thus the number of jigs necessary to complete the test is a quantity that can be used in comparing the relative workability of various mixes.

Because of the great sensitivity of the remolding test, the use of all possible precautions was necessary to obtain consistent results. The coarse aggregate, though furnished to the jobs in two sizes, had to be separated into narrower size ranges to avoid segregation of the small quantities used in the test. The sand was kept moist to avoid segregation. The absorption of the coarse aggregate was ascertained, and the moisture content of the sand was determined, the latter at frequent intervals, and proper corrections for these factors were made in the quantity of mixing water. To eliminate the drying out of a batch during the test, the mixing water was added to the coarse aggregate some time in advance, thus permitting absorption to take place before mixing. The relative humidity was kept high at all times to prevent loss of moisture through evaporation. The personal factor was found to be of the utmost importance in all stages of the test; so, to eliminate errors from this source, definite operations were assigned to each individual. The results obtained indicated that the precautions taken were not only desirable but absolutely necessary.

In making these tests, a carefully outlined procedure was followed throughout. For each water-cement ratio, gravel was combined in various proportions, and with each of these gravel combinations different percentages of sand were added. Using water contents of 6.00, 6.25 and 6.50 gal. per bag of cement with each of the sand and gravel proportions, the cement content was varied from 4.5 to 5.0 bags per cubic yard by 0.1 bag stages. Each trial batch was mixed with a trowel in a mixing pan, and was designed to yield about ¼ cu.ft. of finished concrete. At the time of mixing, observations were made as to the characteristics of the concrete. The batch was then placed in the remodeling apparatus, and the slump and remolding effort were noted and recorded. After the completion of the test, the concrete was examined for bleeding, and a relative index of this

property of the mix was determined by measuring the quantity of free water accumulating on the surface of the mass during the test. These data, aside from the remolding effort, give a comprehensive picture of the mix and serve as a valuable guide in setting up limits in proportioning on the job.

To analyze the data obtained from the test, the remolding effort is plotted against the cement content for each condition, and curves are drawn through the series of points as shown in the upper half of Fig. 2. From these initial curves the family of curves in the lower half of the same figure is developed. These lower curves, representing mixes of equal workability, indicate definitely that the sand content is a very important

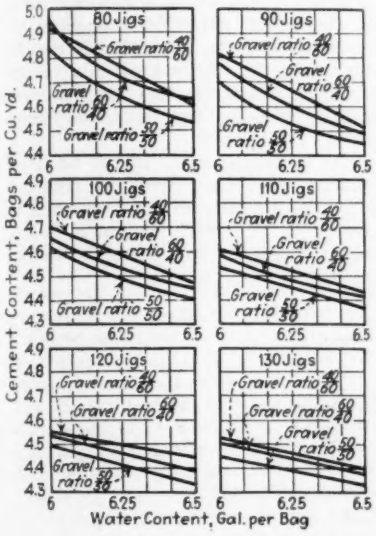


FIG. 4—GRAPHS of relationship between gravel grading and cement requirements in concrete having definite degrees of workability.

factor governing workability. They also show that at some definite percentage of sand, the least amount of cement is required to produce a concrete having a given degree of workability. Although this definite percentage of sand, referred to as the optimum percentage, varies somewhat with changes in the water-cement ratio as well as with the grading of the coarse aggregate, it does not vary appreciably with the cement content. It may be noted also from the curves in the upper half of Fig. 3 *a*, *b* and *c*, inclusive, that, when the optimum percentage of sand is used in each case, the grading of the coarse aggregate has only a slight effect on the cement requirement, although certain gradings do show a slight advantage. Thus, the extreme importance of proper proportioning becomes very apparent if economy and the maximum of desirable qualities are to be attained in the finished concrete.

There appears to be a fairly good general relationship between slump and workability as indicated by the remolding test. This is especially true of mixes having a slump range from 1 to 5 in.; however, outside this range, the relationship becomes less apparent.

Application on the job

The method employed in selecting suitable mixes for the job by application of the data contained in the charts can be described best by illustration. The first step, of course, is the determination of the maximum water-cement ratio with which the required strength can be attained. This is accomplished by making up a preliminary job curve. Generally the required strength could be obtained by using a water-cement ratio in excess of the maximum of 6½ gal. per bag permitted by the specifications. Consequently, any water content not in excess of 6½ gal. per bag should prove satisfactory, and we may now concentrate on arriving at a mix satisfactory in respect to workability and economy.

The degree of workability required on the job will vary with the methods used in transporting and placing the concrete as well as with the intricacy of the forms in which it is to be placed; therefore, this factor cannot be satisfactorily determined anywhere except on the job. From observation of the trial batches, however, we can assume that the most satisfactory mix will have a remolding effort somewhere between 100 and 130 jigs. Now various mixes falling within this range of workability are tried out on the job and the most satisfactory remolding effort is determined. Let us assume this to be 120 jigs.

The next step is to select the most economical combination of materials to produce a mix having this remolding effort. To achieve this end, the cost of sand and gravel must be balanced against the cost of the cement, and it is usually found that in this respect the cement merits first consideration. From the curves in Fig. 3*c* we see that with a maximum water content of 6½ gal. per bag, a mix having a remolding effort of 120 jigs can be produced by the use of 4.37 bags per cu.yd. if the most ideal aggregate combinations are used. The specifications state, however, that the cement content shall not be less than 4.5 bags per cu.yd.; therefore, the water content may be reduced to less than the maximum of 6½ gal. per bag, or proportions other than those giving the greatest degree of workability may be used. We can then assume that in the final mix the cement content will be fixed at 4.5 bags per cu.yd. and that any further economies will have to be effected by the use of favorable aggregate combinations.

At this time let us go back to the aggregate source and see just what the pit run happens to be. Suppose it is found that the average yield is 37 per cent sand and 63 per cent gravel, with the gravel made up approximately in the following order: 55 per cent—No. 4 to 1; and 45 per cent—1 to 2. Inasmuch as it is desirable to eliminate any waste at this point, and as no further savings can be made in cement, the next step is to see if a mix approximating pit-run proportions will have the desired workability and still be within the maximum water limits. From the curves shown on Fig. 3*a* we find that by using pit-run proportions a concrete having a

FIG. 5—TEXTURE OF THE CONCRETE used in construction of St. Paul District locks and dams.

remolding effort of 120 can be produced with 6 gal. of water per bag and 4.5 bags per cu.yd. This then becomes the ideal mix from the contractor's viewpoint. The quality of the concrete is also superior to that required by the specifications.

This perfect combination of materials was not always possible on these projects. Because of the important bearing that sand has on the workability of the concrete, its content can be fluctuated over a narrow range only. Consequently, a considerable amount of this material had to be wasted at the washing plants. In the case of gravel, however, it must be noted that various combinations can be used without appreciably affecting the workability. This fact, together with the relatively wide limits of grading permitted under the specifications, has resulted in practically no gravel waste.

As previously stated, considerable variations were to be expected in the gravel gradings with material taken out of these shallow deposits; using fixed proportions, these changes in grading have serious effects on the workability of the mix. These effects can be greatly minimized, however, by a complete change in the proportions. In such cases curves similar to those shown in Fig. 3*a*, *b* and *c* will prove valuable as an aid in selecting the proper sand content. No job has used a particular mix throughout. The proportions were changed without hesitation from time to time to meet job conditions to the best advantage. In making such changes, curves and charts of the foregoing type were found to be a very helpful guide in arriving at uniform and economical mixes that would prove suitable for the variety of conditions encountered.

Results obtained

Inasmuch as the mixes used at the various jobs were changed from time to time, we cannot link a particular mix with any one job. In the accompanying table, however, some mixes have been selected from those used on each of the jobs to show the diversity of proportions used. All of the mixes presented in this tabulation contain a 2-in. maximum-size aggregate and no admixture. It may be noted that on all of the jobs it has been possible to use the minimum of 4.5 bags per cu.yd. of concrete, though at times it was necessary to increase the cement content to provide concrete of a greater degree of workability to meet particular job conditions of placement. As the amount of added cement used for this purpose was negligible on most jobs, no contractor resorted to the use of admixture except for experimental purposes. The slumps of the mixes enumerated in the table range from ¼ to 1½ in. The concrete was quite cohesive and could be handled without segregation. Bleeding of the various mixes and the resultant sand-streaking of vertical faces gave practically no trouble during the summer months, except in one instance. Although the sand used in this case met specifications in every respect, there was a decided shortage of the extremely fine particles, and no means was found to eliminate entirely water gain in the forms by manipulating the proportions of the different aggregates.

SOME OF THE CONCRETE MIXES USED ON LOCK AND DAM CONSTRUCTION IN THE ST. PAUL ENGINEER DISTRICT

Job	Mix—Dry Weights per Cu.Yd. of Concrete			Cement, Bags per Cu.Yd.	Water, Gal. per Bag	Water-Cement Ratio
	Sand	1 in. Gravel	2 in. Gravel			
Dam 4	1,215	1,406	904	4.50	6.02	0.80
Dam 5	1,269	1,165	1,055	4.50	5.90	0.79
Lock 5A	1,180	1,391	928	4.50	6.30	0.84
Lock 6	1,212	1,150	1,145	4.50	6.10	0.81
Lock 7	1,180	1,393	928	4.50	6.15	0.82
Lock 8	1,195	1,155	1,155	4.50	6.45	0.86
Lock 9	1,253	1,279	1,040	4.50	5.80	0.77

Fig. 7 shows the texture of the concrete as used on one of the jobs. This seems to indicate that the concrete was very harsh and rather hard to handle without segregation, but this is not the case. Although this mix has a rather low slump, it is quite workable and flows very readily when vibrated. After compaction in the forms, workmen may walk on the concrete, leaving only a slight impression. Because of this fact, it is generally assumed to be easier to place than a concrete with a greater slump.

The concrete compressive strength on these jobs averaged from 3,500 to 4,000 lb. per sq.in. at 28 days, which is a safe margin over the 3,200 lb. per sq.in. required by the specifications. Inasmuch as strength may be taken as a fair index of the other desirable properties of hardened concrete, it is believed that by employing this method of mix design a superior concrete has been secured without working any undue hardships on the contractors.

The locks and dams in the St. Paul District were constructed by contract, under the direction of the Corps of Engineers, U. S. Army. Dwight F. Johns, Major, Corps of Engineers, is district engineer.

Settlement of Footings in Alluvial Soil

Bearing tests on Los Angeles basin soils made during the reconstruction following the earthquake indicate variations with size of footing, moisture content and underlying strata

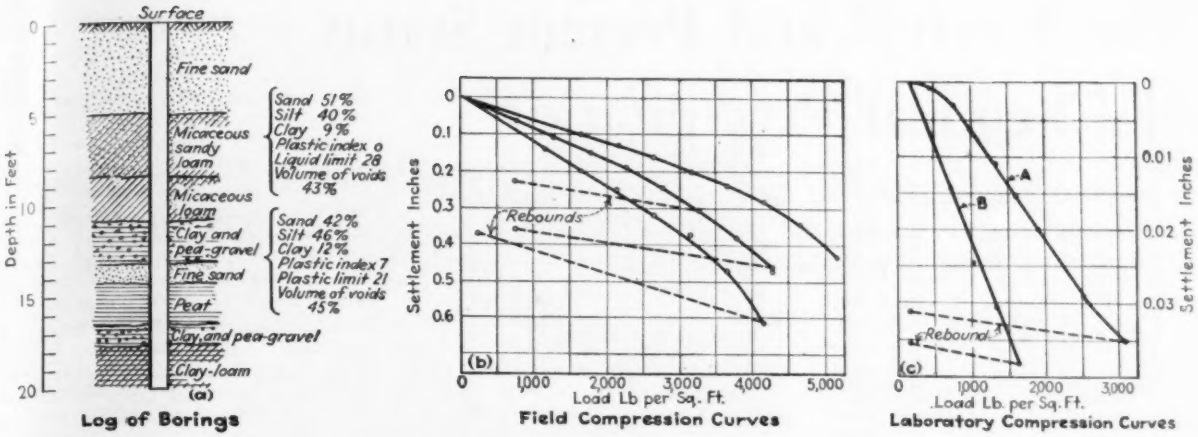
By Frederick J. Converse
Labarre & Converse, Foundation Engineers, Los Angeles, Calif.

FOLLOWING the earthquake of March, 1933, the condition of the foundation of many of the buildings in the deep alluvial basin between Los Angeles and the sea was investigated as a preliminary to reconstruction. The soil in this area is composed of loosely compacted and irregularly bedded sand, silt and clay. The water table is high and fluctuating, and in many places it is within a few feet of the surface.

One of the first of the investigations was at the site of the Willowbrook Junior High School of the Compton school district. The building in question was a two-story brick wall-bearing structure with spread footings 18 to 24 in. below the surface. Preliminary borings (Fig. 1*a*) indicated an overlying bed of very fine sand containing considerable silt, merging into a sandy loam 4 to 5 ft. below the surface. At a depth of about 9 ft. a poorly consolidated and completely saturated plastic loam was encountered, and thereafter alternating thin beds of clay loam and fine sand extended to the depth investigated.

Method of testing

Three circular plates 1, 3 and 9 sq.ft. in area respectively were bedded in the silty loam at a depth of 5 ft. below the surface, at center to center distances of about 13 ft. The diameters of the pits in which the plates were placed were only slightly larger than the plates themselves. Stiffness of bearing surface was obtained by pyramiding several 1-in. plates of various diameters. Loads were applied in increments of 500 lb. per sq.ft., and settlements and time were autographically recorded on a rotating drum chart.



SOIL PROFILE and compression curves determined by bearing tests on soils in the Los Angeles alluvial basin.

The load-settlement curves for the three tests are shown in Fig. 1. The slope of the straight portion of the curves is seen to increase with plate size. The relation between the load, the size of plate and the settlement, within the range of these sizes, is closely given by the equation:

$$s = (.002\,d + 0.037)\,p$$

where s = settlement in inches, d = diameter of plate in inches, and p = unit load in 1,000 lb. per sq.ft.

Since the widths of the existing footings fall within the range of the diameters of the plates, this formula was considered adequate for determining the load required to give a predetermined settlement of any of these footings.

The curves deviate from the straight line at loads of from 2,600 to 3,000 lb. per sq.ft. Shear tests made on undisturbed material gave a value of 1,000 lb. per sq.ft. for soil containing 20 per cent moisture (field condition) and 460 lb. per sq.ft. for saturated soil.

Calculations for the unit load at which plastic flow begins, based on the theory of stress in an elastic isotropic medium and using the above shearing strengths, give 3,140 lb. per sq.ft. for the material having 20 per cent moisture, and 1,450 lb. per sq.ft. for saturated soil. Assuming that the break in the curve of field test indicates the beginning of plastic flow, the calculated value of 3,140 lb. per sq.ft. is somewhat high. Considering the fact that field conditions are far from the ideal conditions on which the theory is based, the agreement is good. The calculated value of 1,450 lb. per sq.ft. for the saturated soil should therefore be a close approximation to the load at which the curve would break if the soil were saturated. Since the soil under the existing footings will be saturated during wet weather, this reduction in bearing value must be considered when estimating allowable loads from field compression tests.

By the elastic theory complete failure should occur under a unit bearing value of 5,140 lb. per sq.ft. at 20 per cent moisture, and 2,360 lb. at saturation. While the field tests were not carried to the ultimate load, it appears from the curves that this value is reasonably close to that given by the load tests.

The curve for the 9-sq.ft. plate falls off rapidly at a lower unit load than those of the other plates. This may be explained by the fact that the stress at the plastic layer some 4 ft. below the plate is greater for the large plate than for the others. The shearing stress at the boundary between the sandy loam and the plastic loam, due to loads on the 9-sq.ft. plate, reaches the shearing strength of the clay at a load of about 2,000 lb. per sq.ft. With higher loads a greater volume of the plastic loam is overstressed, and by the time the overlying sandy loam reaches a stress sufficient to cause it to fail in shear, the plastic loam is able to offer little support, and rapid settlement occurs.

The dash lines marked "Rebound Curves," in Fig. 1*b*, are drawn between the high and low points obtained by releasing and re-applying load, and hence only approximate the actual rebound curves. The rebound curve represents the elastic action of the soil under variations in load and may be used in estimating changes in footing elevations due to live, wind or earthquake loads.

The effect upon settlements of saturating the soil is graphically shown in 1*c*. These curves were obtained from undisturbed confined samples 1 in. thick, tested in compression in the laboratory. The sample represented by curve *A* contained 20 per cent moisture (field condition), while curve *B* was obtained from a similar sample completely saturated. Most engineers and many building codes recognize the fact that moisture content is exceedingly important in interpreting tests on permeable soils, but to date no satisfactory wet test has found extensive use.

It is possible that shear and compression tests made in the laboratory on undisturbed saturated samples may be of considerable value to the engineer in estimating the bearing capacity of light permeable soils that may become saturated.

While the above tests and the conclusions drawn from them are applicable to this particular site only, it is hoped that the presentation of this concrete example will prove helpful in indicating the variations in bearing capacity with size of footing, moisture content of soil and character of the underlying strata, and that it may bring out once more the futility of relying on the results of a single load test on a small plate, for the determination of the bearing value of soils.

Silt Passing Through Reservoir Behind Boulder Dam

Muddy water is being discharged from the mouth of the diversion tunnel below Boulder Dam instead of the crystal-clear stream that has been flowing from the tunnel for several months past, according to a news items published in *The Reclamation Era* for October.

Soon after the reservoir behind Boulder Dam began to fill, the lake became clear and the stream of water discharged below the dam changed from the normal muddy color of the Colorado to a clear stream that was the subject of comment of all who saw it and who had known the Colorado of old. This condition continued until recently when the stream began to carry a silt load, though the lake remained clear. The lake now is about 310 ft. deep at the dam and is 80 miles long.

Two explanations are given of the new development. One is that the silt-laden waters entering the lake far above the dam are heavier than the clear lake water and so move along the bottom to the dam without entirely losing their load of silt. The other is that silt has been deposited in the upper reaches of the lake until it has reached an unstable level, and that it now again is being eroded by the movement of the water along the bottom and so is carried along the bottom to the dam.

The Revival and Present Status of Chemical Precipitation

A review of progress in the last decade which summarizes for the United States the number and location of plants now in use, under construction or projected and the chemicals employed

By M. N. Baker
Upper Montclair, N. J.

● NUMEROUS STATEMENTS that chemical precipitation processes of sewage treatment are about to replace biological methods led the author of this article to make a country-wide canvass to determine how far this movement had gone. With the aid of state, city and consulting engineers, data were gathered which showed that of the 3,500 American sewage-treatment plants, 72 either had installed chemical precipitation equipment or had made plans for its use. Iron compounds, led by ferric chloride, predominate as the favored precipitating agent.

According to Mr. Baker, who views the situation from the background acquired in a half century of association with sanitation developments, as a member of the editorial staff of *Engineering News* and *Engineering News-Record*, the future role to be assumed by chemical precipitation will be chiefly to supplement, rather than displace, present treatment process.—EDITOR.

REVIVAL of chemical precipitation as a method for treating sewage began with a single plant in 1924 at a time when all but one of the relatively few chemical treatment plants built in the United States during the previous 40 years had been or were about to be abandoned. This installation was followed by a half-dozen others in as many years, and since 1930 progress has been accelerated. Today 34 cities have chemical precipitation plants in use, and although this may be a small number compared with the 3,500 municipalities that are now treating their sewage (*ENR*, Aug. 15, p. 234), it is indicative of renewed confidence in a process that was in bad repute for twenty years. In addition to the plants actually in use, eleven others are under construction and 25 have been more or less definitely projected. Experimental work has been conducted in 30 cities.

Included in the 34 plants now in use are two which were variously classed when built, as electrolytic, lime-electrolytic and Landreth direct-oxidation; one at Phillipsburg, N. J., built in 1920 (electrolysis abandoned in 1927); the other and more elaborate one at Winston-Salem, N. C., which went into partial use on Dec. 15, 1926. The latter installation is all that remains to monument 60 years of efforts by a half-dozen European and American promoters of one or another electrolytic process, and it survives only because of the chemical precipitation feature that is combined with electrolysis.

Twenty-Six States Represented—The plants now operating (Table I) are located in 14 states; the 11 under construction are in 9 states; the 23 projected installations are in 13 states; the 30 experimental units are in 15 states. Omitting duplications, 27 states are included. The 21 states reporting no chemical precipitation activities include five of the six New England states, four of the seven in the South Atlantic group, three of the five South Central states, four of the seven Northwestern states, and five of the seven states in the Rocky Mountain and Pacific region. Of the 34 plants in use, 19 (or more than half), are located in three states: Oklahoma, nine; New Jersey, five; Wisconsin, four.

As might be expected in the revival of an old process long in disfavor, most of the cities involved have been small. Thirty-one of the 72 cities that have plants in use, being built or projected, had populations under 10,000 by the census of 1930. At the other extreme are a half-dozen cities that had populations of 100,000 or more in 1930. These are led by Minneapolis and St. Paul, with 1930 populations of 464,000 and 276,000, making a total of 740,000 for the Minneapolis-St. Paul Sanitary District.

Ohio and Wisconsin led revival

Ashland, Ohio, was the place where, quite unwittingly, chemical precipitation was re-established. On July 7, 1924, without the knowledge of the state department of health, Ashland began the use of the Travers marl process, in which a combination of 81 per cent marl, 16 per cent hydrated lime and 3 per cent copperas was added to the sewage as it entered previously-built tanks on its way to sand filters. The filters were soon abandoned because they continued to clog and pond. In 1926 the Ohio state department of health approved the use of the Travers process for primary treatment, provided intermittent sand filters were installed.

In 1925 a lime precipitation plant was built at New Holstein, Wis. Two years later, in Wisconsin, three more precipitation plants were built in the towns of Gillette, Waupun and Westby. Lime was used at Gillette. At Waupun, lime and ferrous sulphate (copperas) were applied to the primary-tank effluent on its way to a mixing tank, where compressed air was introduced for 5 minutes out of each 15 during a detention period of about 40 minutes. The sewage then passed to a final settling tank, from which the sludge was returned to the primary-tank influent. At Westby the sewage went first to an aeration and mixing tank with a detention period of about four hours. Here compressed air was admitted through perforated pipes for 5 min. out

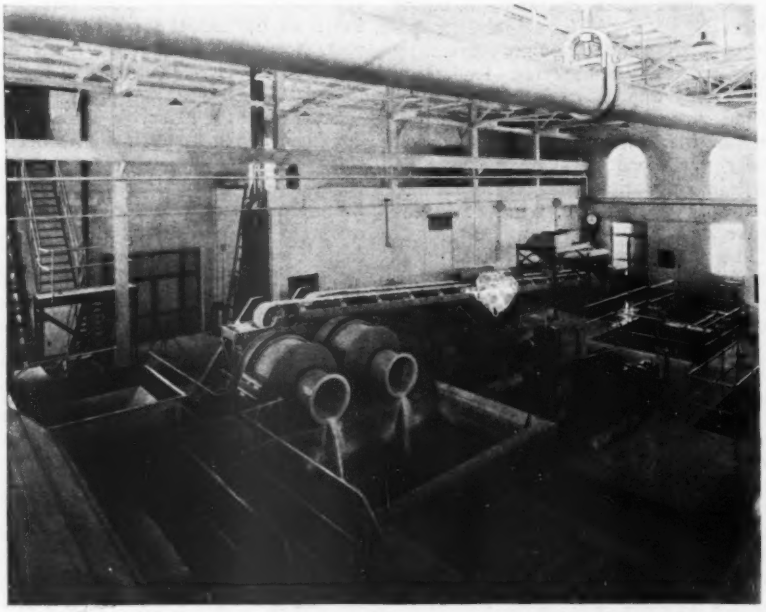


FIG. 1—INTERIOR of the Perth Amboy, N. J., sewage plant, showing one of the most modern installations utilizing a chemical precipitation process. The ferric chloride solution is mixed in a rubber-lined tank in the far corner, and lime is conveyed to an aeration tank by belts that feed into two pulp mills where paper may be added if desired.

FIG. 2—SUPPLEMENTING sewage-disposal facilities at Cedar Rapids, Iowa, this separate chemical precipitation plant for packing-house wastes, built in cooperation with a local industry, affords pre-treatment to 1.2 m.g.d. of trade waste.

of each 15, the object being to prevent septic conditions and to mix the chemicals with the sewage. The pre-aerated and pre-settled sewage was then dosed with lime and alum and passed to a final settling tank. The sludge from this tank was returned to the aeration tank, from which it went to a digester.

Return Sludge Proposed in 1883—This adoption of return sludge at Waupun and Westby preceded by seven years the use of this scheme at Plainfield, N. J., Birmingham, Ala. (Shades Valley plant), and Butler, Pa., and its anticipated use at Virginia Beach, Va. Meanwhile experiments had been made at Wilmington, Del., Palo Alto, Calif., and Plainfield, N. J., in returning chemically-precipitated sludge. The return of "chlorinated concentrated sludge" was tried by promoters at Salem and Cleveland, Ohio, and Rochester, N. Y. However, all these adoptions and experiments were antedated many years and in many places by the return of activated sludge in the process of that name. The idea, in fact, was set forth in 1883 in a British patent granted to Johannes Bock, who also proposed the use of ferric chloride, lime and paper pulp as precipitants.

Part-time and trade-wastes plants

Of the cities having precipitation plants in use, under construction or projected, twenty are for summer-time or occasional use, while in twelve plants trade wastes predominate. Deducting three duplications, 29 of the 72 cities are in either the summer or trade-wastes class, indicated by (S) or (T) in Table I.

Largest of all the plants listed is the 134-m.g.d. part-time plant now under construction for the Minneapolis-St. Paul Sanitary District. Streamflow records show that while plain sedimentation might generally suffice, in some years it might be insufficient for the five-month low-flow river stages (*ENR*, Nov. 8, 1934, p. 601).

Next in size of the summer-time chemical precipitation plants now under construction is the one for the Coney Island section of New York City, to be operated during the ocean-bathing season. This unit has a present capacity of 35 m.g.d., and eventually the plant will be increased to 140-m.g.d. capacity (*ENR*, Oct. 10, 1935, p. 489). A third summer-use plant (10-m.g. capacity) is being built at Waukegan, Ill., by the North Shore Sanitary District, to protect a lake bathing beach. One of the largest projected works is the 42-m.g.d. summer-time installation at Atlanta, Ga. At Gastonia, N. C., a part-time chemical plant will be used in times of excessive flows of dye wastes.

Unique among the part-time precipitation plants built chiefly to treat trade wastes is one completed in July, 1935, for the Beltsville Research Center of the U. S. Department of Agriculture at Beltsville, Md. Wastes from cow stables, a creamery and cheese factory, a hog abattoir and laboratories, all large, pass through bar screens, flocculators, primary settling tanks, trickling filters and final settling tanks. Tannery wastes may be treated later on.

Industrial Cooperation—At three of the plants where trade wastes predominate the contributing industries pay some or all of the extra cost of treatment.

Bad Axe, Mich.—The municipal plant treats cannery wastes with domestic sewage and charges the cannery according to the volume of waste. Ferrous sulphate (copperas) and lime are automatically applied to the sewage, which is distributed alternately to two fill-and-draw cylindrical steel tanks with conical bottoms. Compressed air is used to mix the chemicals with the sewage.

Cedar Rapids—The city has recently added a 1.2-m.g.d. chemical precipitation plant to its normal treatment facilities in which packing-house wastes, pumped across the river, will be separately treated. The effluent from the precipitation tanks is then joined with the 6.5-m.g.d. of pre-settled city sewage, and the combined effluents pass through a dosing tank to trickling filters. The packing industry paid for the chemical pre-treatment works and will share the costs of operation.

Sioux Falls, S. D.—About half of the 6-m.g.d. average flow consists of packing-house wastes. These are equivalent to the sewage of a population of 80,000, or nearly 2½ times that of the city.

TABLE I—PRESENT STATUS OF SEWAGE TREATMENT BY CHEMICAL PRECIPITATION

(Based on returns from state, city and consulting engineers except for some data on experimental plants found in the literature.)

I— Indefinite project. Under Experiment
S— Summer or other part-time use. D—Discontinued.
T—Trade wastes predominate. P— In progress.

Alabama	*In use* (1): Shades Valley, Birmingham (S); *Projected* (2): Ensley District (S), Tarrant City District (S). *Experimental* (1): Shades Valley District. All these are Jefferson County projects.
Arizona	*Projected* (1): Glendale.
Arkansas	*Projected* (3): Fayetteville, Sulphur Springs (S), Waldo (S).
California	*In use* (1): Signal Hill. *Projected* (2): San Diego (very small district), San Luis Obispo. *Experimental* (5): Los Angeles Sanitation Districts (D), Palo Alto (D), San Diego (D), San Francisco, Seal Beach (D). The San Francisco and Seal Beach were on a small scale.
Colorado	*In use* (1): Boulder (S). *Projected* (3): Colorado Springs (S), Denver (I, possible S), Greeley.
Connecticut	*Experimental* (1): New Britain.
Delaware	*Experimental* (1): Wilmington (D).
Georgia	*Projected* (1): Atlanta, 8 plants for Atlanta Sewer District (one S). *Experimental* (1): Atlanta(DP).
Illinois	*Under Construction* (1): Waukegan, for North Shore Sanitary District (S). *Projected* (1): St. Charles. *Experimental* (3): Aurora Sanitary District (DP), Chicago Sanitary District (D), Elmhurst (D).
Indiana	*Projected* (1): Monticello. *Experimental* (1): Valparaiso (D).
Iowa	*In use* (1): Cedar Rapids (T).
Kansas	*Projected* (1): Parsons (T).
Kentucky	*Projected* (1): Providence.
Maryland	*In use*: Beltsville Research Center, U. S. Dept. of Ag. (ST). *Experimental* (1): Hagerstown (D)
Michigan	*In use* (2): Bad Axe (T), Dearborn. *Under Construction* (1): Owosso. *Projected* (2): Grand Rapids (S), Three Oaks. *Experimental* (2): Dearborn (D), Grand Rapids (P).
Minnesota	*Under Construction* (1): Minneapolis-St. Paul Sanitary District (S).
Nebraska	*In use* (2): Lancaster County Sanitary District No. 1 (near Lincoln), York.
New Jersey	*In use* (5): Essex Fells, Lakewood, Perth Amboy, Phillipsburg, Plainfield. *Under Construction* (1): Verona. *Projected* (2): New Brunswick (S), Westwood. *Experimental* (2): Essex Fells (D), Plainfield (D).
New York	*Under Construction* (1): Coney Island Section, New York City (S). *Projected* (3): Auburn, Elmira (I), Freeport. *Experimental* (4): Liberty, Newark (D), New York City (D), Rochester (D).
North Carolina	*In use* (2): Gastonia (ST), Winston-Salem. *Under Construction* (1): Spindale (T).
Ohio	*In use* (2): Ashland, Orrville (T). *Experimental* (2): Cleveland (D), Dayton (P).
Oklahoma	*In use* (9): Cordell, Duncan, El Reno, Enid (S), Fairview, Oklahoma City (2 plants one T), Perry, Stillwater, Temple. *Under Construction* (2): Ardmore, Durant. *Experimental* (1): Oklahoma City (D).
Pennsylvania	*In use* (1): Butler. *Experimental* (2): Butler (D), Philadelphia (D).
South Dakota	*Under Construction* (1): Sioux Falls (S T).
Texas	*Under Construction* (2): El Paso (S), Paris. *Projected* (1): Paris. *Experimental* (3): Dallas (D), Ft. Worth (D), Paris (D).
Virginia	*Projected* (2): Arlington County (entire county), Virginia Beach.
Wisconsin	*In use* (4): Gillette, New Holstein (T), Waupun (T), Westby (T). *Experimental* (1): Waupun.

TABLE II—CHEMICAL PRECIPITANTS FOR SEWAGE IN USE OR PROPOSED

Plants: U—in use. C—under construction. P—indefinite. E—experimental.
Chemicals: Anhy—Anhydrous $FeCl_3$. CSI—$FeCl_3$ made locally from chlorine and scrap iron. LB—Liquid $FeCl_3$ bought.

Ferric Chloride (29)
(In some cases lime also used.)

U. Essex Fells, N. J.; CSI
U. Gastonia, N. C.; anhy
U. Orrville, Ohio; anhy
U. Lancaster County, Neb. San. Dis. No. 1; CSI
U. Kahoka, Mo.; anhy
U. Cordell, Okla.; CSI
U. Duncan, Okla.; CSI
U. El Reno, Okla.; CSI
U. Enid, Okla.; CSI
U. Fairview, Okla.; CSI
U. Stillwater, Okla.; CSI
U. Temple, Okla.; CSI
C. Owosso, Mich.
C. Sioux Falls, S.D.; anhy
C. El Paso, Tex.; CSI
C. Paris, Tex.; CSI
C. Ardmore, Okla.; CSI
C. Durant, Okla.; CSI
P. Freeport, N. Y.
P. Providence, Ky.
P. Grand Rapids, Mich.
P. Fayetteville, Ark.; CSI
P. Sulphur Springs, Ark.; CSI
P. Waldo, Ark.; CSI
P. San Diego, Calif.
P. Greeley, Colo.; CSI
P. San Luis Obispo, Calif.
P. Glendale, Ariz.
PI. Denver, Colo.; CSI(?)

Ferrous Sulphate and Lime (4)

U. Bad Axe, Mich.
U. Waupun, Wis.
C. Minn.-St. Paul, Minn.
PI. Elmira, N. Y.

Chlorinated Copperas (9)

U. Lakewood, N. J.; since July '35
U. Plainfield, N. J.
U. Verona, N. J.
U. Birmingham, Ala. (Shades Valley)
U. Boulder, Colo.; Jefferson City, Ala.
C. N. Y. City (Coney Island)?
P. Ensley, Ala.
P. Tarrant City, Ala.
I. New Brunswick, N. J.

Chlorinated Copperas and Lime (2)

U. Beltsville, Md. (U.S.D.A.)
P. Virginia Beach, Va.

Iron Salts (2)

P. Westwood, N. J.
PI. Parsons, Kan.

Ferric Chloride and Lime (9)
(Probably some cities in the preceding list belong here.)

U. Perth Amboy, N. J.; $FeCl_3$ in summer only; bought.
U. Butler, Pa.
U. Dearborn, Mich.; LB
U. York, Neb.
U. Neosho, Mo.; CSI
U. Oklahoma City, Okla.; CSI
U. Perry, Okla.; CSI
C. Waukegan, N. Shore San. District, Ill. (?)
P. Parsons, Kan.; CSI

Ferric Chloride, Lime and Charred Sludge (3)

P. Monticello, Ind.
P. Three Oaks, Mich.
P. St. Charles, Ill.

Ferric Sulphate and Lime (1)

P. Colorado Springs, Colo.

Ferrous Sulphate (1)

P. Atlanta, Ga.

Lime (4)

U. Phillipsburg, N. J.
U. Winston-Salem, N. C.
U. Gillette, Wis.
U. New Holstein, Wis.

Lime and Alum (1)

U. Westby, Wis.
U. Signal Hill, Calif.

Marl, Lime and Ferrous Sulphate (1)

U. Ashland, Ohio

Precipitant not Decided (3)

C. Spindale, N. C.
P. Auburn, N. Y.
P. Arlington County, Va.

Mechanically cleaned settling tanks followed by trickling filters were installed in 1927, but they became clogged in 1932, and the final effluent caused a nuisance in the receiving stream. To remedy this condition, it is proposed to treat the packing-house wastes separately with ferric-chloride precipitation and pass the effluent, together with that from the domestic sewage plain settling tanks, through the existing city-owned trickling filters, followed by treatment in a new activated-sludge plant. It is expected that the additions will be completed about Dec. 1, 1935. The packing industry may be asked to pay a part of the cost of operating the joint works.

Ferric chloride dominant

A striking feature of the revival of chemical precipitation is the general use of iron salts as precipitants and the subordinate rôle of lime. Ferric chloride dominates but is far from being new. It was used at Coney Island, N. Y., in 1887 and at several other plants a little later and was included in the Bock patent of 1883.

The chemicals used or proposed to be used in the cities for which data are available are classified in Table II. Iron salts, alone or in combination with other agents, generally lime, are indicated for 59 of the 66 plants. Ferric chloride leads, being listed alone or with lime in 41 cities. Ferrous sulphate (copperas), alone or in combination (not counting one in the lime group), is reported for sixteen cities; in ten plants it is used with chlorine to produce chlorinated copperas locally, and in seven installations it is accompanied by lime.

The lime group has six cities: four use lime alone; one uses lime and alum; one, marl, hydrated lime and ferrous sulphate. About twenty other cities use lime in connection with some other chemical.

In at least 24 of the 41 cities in the ferric-chloride group the chemical is made locally from chlorine and scrap iron. Of the eight cities known to buy ferric chloride, four use the anhydrous form, while two—Dearborn and Grand Rapids—buy the liquid form. At Dearborn this is a change from the initial practice of making the agent from chlorine and tin cans. Dearborn has also given up the use of ground paper pulp from city wastes as a precipitant, but it still uses Prestolite waste lime. So far as can be determined, no city is now using ground paper; it was proposed for the new Perth Amboy plant, but it has not been used thus far.

Experimental plant installations

Nearly all the 30 experimental plants listed in Table I were initiated and operated by promoters of chemicals or of apparatus, or of some "process." Some cities have cooperated in the tests without otherwise bearing expense. Most of the cities have simply allowed the experimenters to set up and operate their own testing equipment. The capacities of these plants have ranged from 24 gal. a day to 500,000.

Only a half-dozen of these cities have as yet adopted chemical precipitation, and of this small group the process installed was decided upon before the experiments were started. The earlier of two series of experiments at Atlanta, Ga., was conducted, and plans for sewage disposal for the city were outlined by a large staff, at the expense of promoters, with no action by the city except permission to carry on the work. Two years later the city began experiments of its own, now in progress, partly with loaned equipment (*ENR*, May 30, 1935, p. 792, and Oct. 31, 1935, p. 624). The Atlanta Sewer District proposes to have eight chemical precipitaiton plants, ranging from 0.25- to 42-m.g.d. capacity.

Future prospects

The decline and temporary abandonment of chemical precipitation in sewage treatment were due to the handicaps imposed by the need for expensive chemicals, which produced large volumes of sludge, and the competition offered by biological processes that economically provided complete and satisfactory purification. The revival of interest in chemical treatment can be attributed, not to the discovery of new precipitants, but to the lower prices now prevailing for those originally proposed as most suitable and to the adaptation of mechanical appliances recently perfected in sewage-treatment practice and other fields of industry. To this may be added the growing appreciation and recognition that chemical-precipitation methods offer a flexible process of sewage purification, going somewhat further than plain sedimentation and, where secondary treatment is required, lessening the burden on biological processes.

Present indications are that the use of chemical precipitation will increase with a fair degree of rapidity, but chiefly to supplement rather than displace other processes. A hopeful promise for the future is a saner attitude and more scientific spirit on the part of promoters than prevailed until recently. This will encourage cooperation between promoters and the professional advisers of cities and thus beget confidence in city officials responsible for the choice of sewage-disposal methods.

All signs point to the construction of hundreds of sewage-treatment plants in the next decennium, in which chemical processes will have the share that recent advances fully warrant.

Road-Base Stabilization with Portland Cement

Test sections of cement-stabilized-soil bases for bituminous surfaces in South Carolina indicate possibilities that warrant extension of investigation

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A GREAT PORTION of the mileage in the highway system of South Carolina consists of roads that are not heavily traveled, and for these roads a bituminous surfacing on an earth base serves the needs of traffic satisfactorily. The selection of base material for such roads is a serious problem, and much time has been devoted to the study of soils that can be used successfully. The soils used are locally classified as topsoil and sand clay, and to obtain satisfactory soils it is frequently necessary to haul material for several miles.

Several years ago the state highway engineer, Charles H. Moorefield, suggested as a problem for research a study of the possibility of mixing portland cement with soil, to form a base for bituminous-surface-treated roads. The idea has been to develop a base material that could be used in lieu of sand clay or topsoil. A wearing surface of some description on this base material is considered essential.

Preliminary laboratory experiments

Mixtures of portland cement with topsoil and with sand were first molded into pats 8 in. in diameter by 1 in. thick. These specimens were exposed to the weather for a time, and they showed that a mixture of cement with topsoil would resist disintegration from rain very much better than the soil alone or than a mixure of cement with sand.

In December, 1932, two experiments were made in the driveway at the laboratory; these consisted of mixing cement with a topsoil and with a sand clay containing about 50 per cent clay. Cement was mixed in the proportions of 1, 2, 3 and 4 bags per cubic yard. The mixing was done by hand, and sufficient water was added to make the mixture plastic. These mixtures were tamped into blocks about 2 ft. square and 8 in. deep in holes in the driveway. These specimens have been exposed to the weather and traffic continuously; all show wear apparently in inverse proportion to the amount of cement they contain; none have disintegrated. In October, 1933, a small plug containing about 9 cu.in. was cut from each specimen and boiled for 15 hours. No softening or disintegration occurred, but the soil without the admixture of cement softened rapidly on exposure to steam.

From these experiments it seemed probable that cement at the rate of 2 bags per cubic yard was sufficient to

CEMENT-STABILIZED-SOIL ROAD CONSTRUCTION: A—Cement being applied by spreader box hauled by motor truck. B—Mixing cement and soil with a road grader. C—Sprinkling dry-mixed cement and soil which has been bladed smooth. D—Compacting finished surface with a dual-tire motor truck.

EXPERIMENTS WITH CEMENT-STABILIZED-SOIL BASES FOR BITUMINOUS-SURFACED ROADS IN SOUTH CAROLINA

	Cayce		Kingsburg		Parksville		M
	Sect. 1	Sect. 2	Sect. 1	Sect. 2	Sect. 1	Sect. 2	
Date constructed	12–16–33	7–13–34	7–25–34	7–26–34	8–8–34	8–9–34	8–
Length	525	1,050	525	1,050	1,050	650	
Width, ft.	20	20	20	20	20	20	
Type soil	Sand clay	Sand clay	Fine sand clay	Fine sand clay	Top soil	Top soil	Red
Analysis of soil							
Percent retained on No. 10 sieve	3.0	3.0	1.0	2.0	30	30	
Silt, per cent	5.0	5.0	14.0	10.0	29	29	
Clay, per cent	21.0	21.0	19.0	24.0	24	24	
Amount of cement:							
Bags per sq.yd.	0.45	0.45	0.45	0.45	0.45	0.34	0.
Bags per cu.yd.	2.0	2.0	2.0	2.0	2.0	1.5	2.
Amount water, gal.	2,350	8,400	2,200	5,200	9,000	5,000	3,000
Approx. gal. per sq.yd.	2.01	3.60	1.89	2.23	3.86	3.46	2.
Curing agent	130-ft. canvas	None	None	100-ft. asph. emulsion	Water 8 and 2:30 p.m.	Cutback asphalt 100	Cutback asphalt 120
Construction Data							
Time spent mixing, hours	6.0	5.0	4.0	6.0	5.5	8.0	5.
Time spent watering, hours	2.0	2.0	0.75	1.5	3.0	2.0	2.
Time spent machining and compacting	1.5	2.0	2.0	1.5	2.0	2.5	2.0
Bituminous Wearing Surface							
Date laid	9–3–34 9–8–34		11–15–34		10–12–34 10–16–34		10–12–34 10–16–34
Condition of base	Dry		Dry		Damp		Damp
Amount of prime gal. per sq.yd.	0.19		.....		0.15		0.15
Amount of cutback asphalt, gal. per sq.yd.	.44 to .81		0.32		1.5		1.0
Amount of stone	40 to 50		.....		.....		.....
Amount of sand	0–37		5		85		65
Cost Per Square Yard							
Cement (based on $2.40 per barrel)	0.270	0.270	.....	0.270	0.270	0.204	0.270
Placing cement	0.214	0.161	.....	0.128	0.090	0.090	0.090
Surfacing	0.137	0.137	.....	0.046	0.281	0.281	0.239
Total	0.621	0.568	.....	0.444	0.641	0.575	0.599

stabilize topsoil or sand clay. Several larger sections were then placed in the driveway at the laboratory in October, 1933. These experiments confirmed the information obtained on the smaller sections except that the topsoil section did not turn out well probably due to the fact that the soil was very high in organic matter.

Field experiments

Cayce Experiment—This experiment was conducted in a typical sand-clay soil. The first part was constructed during December, 1933. The cement was spread on top of the pulverized soil from stone spreaders attached on the rear of trucks at the rate of one bag per lin.-ft. of 20-ft. roadway. This amount is equivalent to 2 bags per cu. yd. considering the mixture 8 in. thick. After all cement was placed, it was mixed in place with the dry soil until the mixture was of a uniform color. At this time water was applied with an asphalt distributor, and mixing continued. A total of 2,400 gal. of water was applied, after which machining and compacting were started. Compaction was secured with a 5-ton roller. The next morning an attempt was made to refinish the surface with a road machine, but the mixture had set so hard that this was impossible. The experiment was opened to traffic about two days later. The air temperatures during the first three days after construction were 42 deg. F. minimum and 83 deg. F. maximum; during these days it was damp, and fogs occurred frequently at night.

The second part of the Cayce experimental road was constructed on July 13, 1934; this was an extension of the previous section. A spreader was used to distribute the cement at the rate of one bag per lin.-ft. of 20-ft. roadway. The bags of cement were handled and dumped by hand, and each trip of the spreader covered only one-third the width of the roadway. Much time was lost in refilling the spreader, as it held only 20 bags. Mixing of the dry soil and cement was done with two disk harrows supplemented by a disk plow. About 8,000 gal. of water were applied uniformly over the surface after dry mixing was complete. Compaction was secured with loaded dual-wheel trucks; finishing was done with road machines. This section was opened to traffic 24 hours after its construction. Hair cracks were observed before it was opened to traffic. The maximum temperatures during the five days following construction were 100 deg. F., and the minimum 70 deg. F. No rain occurred during the five days.

Kingsburg Experiment—The soils in this experiment are of three closely-related types. All of the particles will pass a 10-mesh sieve, and the clay content varies from 19 to 24 per cent. One short section, about 75 ft., contained considerable organic matter, and here the soil was black in color. This road was constructed on July 25 and 26. The equipment and methods of construction were similar to those used in the second section of the Cayce experiment except that the mixture of cement and dry soil was turned over twice with a road machine before any water was added and the surface was machined the morning after construction to remove ruts left by the trucks used in compacting the surface. Only 525 ft. were constructed on the first day and 1,050 ft. on the second day. A cover of loose earth was placed over the first 50 ft. on the end of the section constructed the first day, so that the equipment used on the remainder of the experiment could be turned. A very poor connection between the two sections was secured at this point. Rain occurred almost daily on this experiment for the first five days after construction, and the maximum temperatures each day were close to 100 deg. F.

Parksville Experiment—This section was constructed on Aug. 8 and 9. The soil consists of poor-quality topsoil in which the binder is not sufficient to hold the soil together in dry weather. The soil contained 30 per cent quartz fragments retained on a No. 10 sieve, 29 per cent silt and 24 per cent clay. The construction methods were similar to those used in the Kingburg experiment. Cement for the first part of the experiment was applied at the rate of 2 bags per cu.yd. and for the second part at the rate of 1½ bags per cu.yd. The day after construction the water was applied in the morning and again in the afternoon to the first 1,000 ft. of the experiment, to aid in curing. Cutback asphalt was applied the morning after construction to 100 ft. This was to serve as a prime for the future bituminous treatment and as a curing agent. No hair cracks were observed until some time after construction. No rain occurred for the five days after construction was completed.

Modoc Experiment—This section was placed on Aug. 9, 1934. The soil is a very plastic red clay containing approximately 54 per cent clay. Cement was applied at the rate of 1 bag per lin.-ft. of 20-ft. roadway. Weather conditions were similar to those for the Parksville experiment. Numerous hair cracks appeared by 9 a.m. the morning after construction.

The accompanying table gives com-

plete information as to the details of the above experiments, also the cost data on each experiment as well as the cost of the bituminous wearing course that was applied. Very shortly after the first section of the Cayce experiment was constructed, it was observed that the surface was not slick when wet. This fact was observed also in all of the other experiments, even on the part of the Kingsburg experiment, which was rich in clay, and on the Modoc experiment, where the clay is extremely plastic.

Cracking in the surface immediately after construction has been mentioned; these cracks appear to be normal shrinkage cracks, and the amount of cracking seems to depend on the clay content of the soil. On an inspection trip on Jan. 9, 1935, during a rain, it was observed that the cracks had all disappeared on the portions of the Cayce, Modoc and Parksville experiments that had been left untreated. On an inspection trip in July, 1935, cracks were observed, but they were not as numerous as they were immediately following construction.

Cores were drilled from each of these experiments to learn the depth of stabilized soil. The average thicknesses obtained were 4.1 in. for the Cayce experiment, 4.8 in. for the Kingsburg experiment, 1.6 in. for the Parksville experiment and 2.2 in. for the Modoc experiment. The thickness of the stabilized soil as shown by the cores is not as much as was expected. The plans intended that the cement would be mixed in the loose dry soil for a depth of 6 in. after the mixture was wetted.

It was at first thought that the cement in the soil immediately below the hard crust had not set due to insufficient moisture, and chemical tests were made on samples from the core and the loose material beneath the core. These tests showed that the cores themselves contained only about the theoretical amount of cement. It is evident, therefore, that some of the cement was lost in the mixing and placing operation.

A test was made in the laboratory before the above-mentioned chemical tests, to determine whether or not water would be drawn into the soil from a top moist layer. This test was conducted by mixing cement at the rate of 2 bags per cu.yd. with dry soil. A part of this mixture was tamped into a layer 3 in. thick in a glass bottle having a porous bottom. The other part was wetted, and after the water was thoroughly mixed the mixture was tamped into the container on top of the dry material. The part that was placed dry showed no sign of hardening at the end of a week, but the top moist part had set hard. There was no evidence of penetration of moisture from the moist layer into the dry layer. After seven days, water was allowed to enter from the bottom by capillary action, and after several wettings in this way the bottom layer set a very little, but it was only a fraction as hard as the top layer. This test confirms the original idea that water must be added immediately after the cement. The bottom layer did not set up as hard as the top player, partly because the full strength of the cement could not be obtained as water for hydration was not available, but mostly because the bottom layer could not be compacted into as dense a mass when dry as the top layer, which was compacted in a plastic state.

Additional laboratory tests

One cycle of freezing and thawing tests show that some of the mixtures will withstand freezing and thawing while others disintegrate. Cores from the different experiments were placed in water with about one-half of the core submerged. There was no evidence of softening of the cores, although water rose very rapidly to the top.

Tests have been made with mixtures containing ¾, 1 and 2 bags of cement per cu.yd. with clay soil molded into specimens and allowed to harden and then broken. The material was then pulverized, rewetted and remolded. This cycle was made three times. Tests for the liquid limit and plasticity index were made on samples after each cycle. Even with ¾ of a bag per cu.yd. the plasticity of the clay was to a large extent destroyed, but the material still retained some binding properties.

Conclusions

At the present time, all of the field experiments are in good condition, and no disintegration has been observed. Definite conclusions cannot as yet be formulated. The experiments show, however, that portland cement when mixed with certain types of soil will stabilize that soil to an appreciable extent, and that the addition of portland cement to clay practically destroys the plasticity of the clay. Methods of construction must be improved considerably before this type of soil stabilization can be used extensively. The method for applying water and the method of mixing are not satisfactory. A mixing machine that would apply the cement and the right amount of water to the soil during the mixing operation would be much better than the methods used in these field experiments. An additional field experiment covering 1½ miles will be undertaken very soon.

Sprinkling-Filter Requirements Revised by New Jersey

New regulations drafted by the state health department permit an increased volume of sewage to be treated per unit of filter bed—Rates of application during dosing period are specified

DETAILED SURVEYS and studies made by the New Jersey Health Department, directed toward securing the maximum efficiency from the sprinkling-filter process of sewage treatment, have resulted in recent revisions in the state requirements governing the design and operation of these units in disposal plants. The recommendations outlining the changes were adopted at a meeting of the department held on Nov. 12, 1935, according to a report from J. Lynn Mahaffey, director, and they amend previous regulations in force since Aug. 11, 1925.

The new schedule makes it permissible to treat 630,000 gal. of sewage per day per acre per foot of depth of the filter as against a volume of 300,000 gal., the former maximum figure. Chemical precipitation, as an adjunct to preliminary sedimentation preceding filtration in cases where the 5-day biochemical oxygen demand of the raw sewage exceeds 325 p.p.m., and as a supplement to final sedimentation, is recommended for consideration. Other changes are concerned with the maximum and minimum effective depths of the filter bed, the dosing cycle and the required head on the sprinkler nozzles. The new requirements in full are as follows:

General

1. Sprinkling filters shall be preceded by efficient sedimentation.

2. The minimum effective depth of filtering media at any point in the filter shall be not less than 6 ft. and the preferable maximum depth shall not be more than 9 ft. The effective depth shall be the distance from top of stone to top of underdrains. The effective volume shall be that volume that complies with the aforesaid effective depth.

3. The filtering media shall be from 1 to 2 in. in size, free of fines; and the crushed stone shall comply with the sodium-sulphate soundness test prescribed by the American Association of State Highway officials.

4. Means for the complete flooding of the filter by sections are desirable.

5. Underdrain ventilation shall be provided.

6. When the 5-day biochemical oxygen demand of the raw sewage exceeds 325 p.p.m. sprinkling-filter treatment is not desirable unless preliminary sedimentation

is supplemented by an additional method of treatment, such as chemical precipitation.

7. (*a*) The volume of sewage to be treated by a sprinkling filter shall not exceed 630,000 gal. per day per acre per foot of depth.

(*b*) The average rate of application of sewage during the dosing period shall not exceed either of the following:

(1) 1,100 gal. per minute per acre per foot when the 5-day B.O.D. of the raw sewage is equal to or less than 215 p.p.m.

(2) $\frac{215}{\text{5-day B.O.D. raw sewage}} \times 1{,}100$ gal. per minute per acre per foot when the 5-day B.O.D. of raw sewage is greater than 215 p.p.m.

(*c*) The operating time of the filter shall be not less than 20 per cent or more than 40 per cent of the day.

Secondary tank

1. Sprinkling filters shall be followed by a settling tank; if flat bottom, two compartments shall be provided. Total detention period, based on average daily flow, shall be not less than one hour. Consideration should be given to supplementing sedimentation by chemical precipitation and to the installation of mechanical sludge-collecting equipment.

2. Sludge disposal from secondary tanks.

(*a*) If separate sludge-digestion tanks are provided, the sludge from the secondary tank shall be discharged thereto, and a volume of not less than ½ cu.ft. per capital shall be provided for this sludge.

(*b*) If separate sludge-digestion tanks are not provided, the sludge from the secondary tanks shall be discharged to glass-covered drying beds, and the area provided therefore shall be not less than ¼ sq.ft. per capita; otherwise, the matter of secondary-tank sludge disposal shall be considered as a separate problem at each installation.

(*c*) If pumping is necessary, the piping and pumping equipment shall be a permanent installation.

Fixed nozzle

1. Twin dosing tanks shall be provided, and they shall have a common nozzle field.

2. The dosing cycle (the time interval to fill and discharge one siphon chamber completely) shall not exceed 15 min.

3. The net terminal head on nozzles shall be not less than 1½ ft.

4. Half nozzles or equal shall be provided at the sides of the filter bed.

5. Detailed information shall be furnished in regard to the coverage efficiency of the nozzles.

6. Consideration should be given to means that will permit the removal from service of either half or any quarter of the nozzle field.

Rotary or traveling distributor

1. The filter retaining wall shall not extend more than 3 in. above the filtering media.

2. Valves shall be provided to permit cutting out of service any filter unit.

Confusion in the Works Program

Eight months' operations, marked by lack of policy or planning, bickerings between bureaus, and changes of rules, have produced much less than half the employment intended and converted the promised program of useful public works to a new CWA

Special Correspondence

EVER SINCE JANUARY, when the President proposed to Congress a great emergency relief-works program and asked for $4,000,000,000 to carry it out, the country has been told that 3½ million idle workers would be given jobs speedily. Months later, November was set as the time when this objective would be reached and the program would be under way at full speed. That deadline period is at hand. What are the results?

Eight months of operations since Congress passed the huge appropriation are summed up in the fact that only 70 per cent of the total has been actually allotted for work projects of any description, and that employment totaled only 2,367,242 on Nov. 16, the date of the last report. This number included 539,000 CCC workers and (as nearly as can be estimated) some five to eight hundred thousand ERA workers taken over from the state emergency work systems. The net new employment created by the program thus may be as low as 1,000,000—for the CCC and the state ERA organizations were going concerns before the relief-works program was conceived. Thus the promise of 3½ million men put to work by November is not more than one-third fulfilled.

Months of time were lost in organizing and setting up rules of procedure last spring. Later, administrative conflicts of every kind developed. While the magnitude of the problem and the resulting administrative inefficiency may be responsible for the present results, charges of political motive—a desire to delay initiation of the program so that it might continue to the presidential campaign—have not been wanting.

In the works program as it exists today there is no more evidence of definite policy or planning than there was last January. At that time President Roosevelt assured Congress that the four billions, the largest peace-time appropriation in history, would be expended in creating employment for 3½ million men on useful public works. The results to date throw a curious light on the interpretation of the term "useful public works." They show at any rate that in the main it does not mean public improvements of the PWA kind.

Pressed by Congress for some idea of the nature of the projected works program that he had in mind, the President set up a schedule of allocations so broad that it had no real significance, as subsequently developed. Of primary interest was the allocation of $900,000,000 for grants and loans to states and their political subdivisions, later increased to $1,700,000,000 by the President under authority of the law. This was apparent assurance that a considerable proportion of the funds appropriated by Congress would be spent through the Public Works Administration (PWA) for an extensive program of needed municipal and state improvements.

In the meantime, however, the President had created the Works Progress Administration (WPA), with Harry Hopkins in charge, to "recommend and carry on all useful projects designed to assure a maximum of employment in all localities." The practical result of this delegation of authority to Hopkins was to subordinate projects scheduled by PWA to a vast impalpable program of made work. The subordination was further increased by handicapping PWA through limitations on man-year cost and the requirement that 90 per cent of all labor employed must be drawn from relief rolls. It is strange to find that despite the serious effect of the limits set on man-year cost of projects the program actually will come to an end in eight months, if the purpose to close out by next July all work except federal, PWA and housing construction is adhered to.

Hundreds of PWA projects were rejected by WPA (which was given the deciding voice) as not eligible for funds. At the same time WPA sought to sweeten its own program with projects that, regarded from both engineering and financial standpoints, should have been set up on the 45 per cent grant-55 per cent loan basis established for PWA's program. It was believed in midsummer that this conflict was eliminated by the President's decision ordering WPA to confine itself to projects not exceeding $25,000 in cost, larger projects to go to PWA, but events proved the contrary.

The order failed to bind WPA's policy. As a practical fact it did not determine how the $1,700,000,000 available for local public improvements would be divided between WPA and PWA. When PWA Administrator

Ickes approved a project, he had to meet rigid limitations on man-year cost. If the four billion dollars were to employ 3½ million men for a year, they could not cost more than $1,140 per man-year, and it was ruled that only *direct employment at the site* should be counted. Construction projects requiring materials and machinery produce much of the employment away from the site. The result was to put normal projects under an impossible handicap.

In addition, there was direct rivalry and jockeying for advantage between the Hopkins and Ickes organizations. Part of this was due to the lack of a sufficient number of WPA projects, which caused state WPA administrators to consider projects that were within the range allocated to PWA. The WPA not only was PWA's competitor but had the power to reject PWA applications on the man-year-cost rule and adopt the projects as its own.

When Ickes appealed to the President, after he had seen most of his projects thrown overboard by WPA, it was decided that PWA should have $331,349,589 of that sum, or less than 20 per cent. This amount provided grants (covering 45 per cent of cost) for 3,835 projects. Of the other 80 per cent, or one and a third billion, by Nov. 16 WPA allotments had reached a total of $1,067,492,836, to be spent by state WPA administrators in their own discretion on projects selected from an approved list totaling more than 3¾ billion dollars.

Even after the dominant character of the program became evident, it developed that its execution would have to wait upon Comptroller-General McCarl. Warrants actually releasing funds hung upon a minute examination in the General Accounting Office, which office until recently was physically unable to handle the huge volume of project proposals.

Changing the rules in mid-game

Bickerings between government bureaus were not the only source of delays, grief and confusion. Labor as usual did its part to mess things up. Defeated in Congress in their fight for the prevailing wage, American Federation of Labor officials never let up in their bombardment of the WPA monthly wage schedules originally prescribed to carry out the President's "security wage" promise. At first, Hopkins refused to budge, but finally he weakened and allowed his state administrators to ignore the previously established minimum of 120 hours a month, with the result that many hourly rates have been raised considerably. There is no more money in the pay envelopes, but the workers have gained the privilege of doing less work—in short and ugly words, loafing.

PWA had no such trouble. Its rules required prevailing-wage rates to be paid on all of its projects. However, many contractors sought permission to hire men previously employed by them, and, further, union labor demanded preference. The requirement that 90 per cent of labor be employed from relief rolls cracked under the strain. Hopkins, who under the President's confusion-creating system of organization made labor rules for Ickes' PWA as well as for his own WPA, finally ruled that on contract jobs (which are practically all confined to PWA), when contractors desired organized labor, the agencies of the U. S. Employment Service should furnish employees from lists supplied by the unions.

Hopkins discovered likewise that his own WPA program could not be carried on under the restrictions with respect to employment of labor. State administrators were therefore advised on Nov. 9 that the wages of 10 per cent of the total number of workers employed in their respective states might exceed the established schedule of monthly earnings, in the hope that this "makes it possible for every state administrator to work out his employment with full flexibility in the selection and placement of workers under any labor conditions that may exist."

More handicaps to useful public works

It is impossible to delineate all the ramifications of the works program in which the executive direction floundered before it came to realize that Washington rules necessarily must yield to actual conditions prevailing in the field. Eight months have passed while WPA has been groping toward the light. Because of the long delay, $817,000,000 of the $4,000,000,000 works appropriation has been dissipated for direct relief.

Realizing late in August that the works program had bogged down, President Roosevelt sought to recover lost ground by fixing a series of deadline dates by which the program shall have passed a given point. The last is Dec. 15, by which date all PWA contracts must be awarded, except for municipal power projects. Unable to meet this deadline, the sponsors of many PWA projects will lose their allotments.

Another handicap to PWA progress is that many cities are finding actual bids so high that they will be forced either to abandon their projects or, as suggested by Administrator Ickes, shift from a 45 to a 30 per cent grant basis in order to reduce the man-year cost chargeable to the federal government's contribution. Ickes has stated, however, that there will be every disposition to protect the sponsors of its projects if there is any reason to believe that there is collusion among bidders. It is suspected that some bidders seek to take advantage of the fact that, in order to be sure of holding their PWA allotment, the sponsors will have to let contracts inside of two weeks—due to the fact that months of delay in other quarters kept PWA from getting under way in time.

Internal confusion in WPA

WPA has attained only half its assigned objective. Here the situation today is largely the result of internal confusion, coupled with the difficulty of adapting itself to meet conditions out in the states. WPA state works programs, set up for speed, have not shown any greater acceleration than WPA's program.

Charges of wholesale boondoggling are exaggerated, however. Indeed, WPA includes a large number of projects that properly should be financed either through PWA or from the city's own budget. WPA projects vary widely in character. Roads constitute 43.7 per cent of allotments, followed in order by sewers and watermains, 11.5 per cent; schools and other public buildings, 8.4 per cent; parks and other recreation facilities, 8.3 per cent; conservation and reforestation, 4.8 per cent; reclamation and flood control, 4.1 per cent; and bridge and viaduct construction 1.1 per cent. White-collar projects account for 3.6 per cent of the total. The remainder, or about 25 per cent, is a potpourri of miscellaneous work.

The preponderance of road, water, sewer and building construction, says Administrator Hopkins, "indicates what the communities of America especially want done under the WPA and shows beyond a sensible doubt that there is a vast amount of solid needed improvement throughout the country to provide useful employment. The whole program is good solid stuff, and every single project is something that responsible local or state sponsors have asked for." This also is exaggeration. There is a tremendous amount of made work, leaf-raking and idling.

Edward J. Harding, managing director of the Associated General Contractors, disagrees with Hopkins: "Feeling is very decisively crystallized within the industry that made work of little or no permanent value has been permitted to absorb entirely too large a proportion of the $4,000,000,000 program, at the expense of legitimate useful public works, such as were intended by Congress." He said that the general contractors, in convention at Miami, Jan. 13-15, will demand definite safeguards against the "sabotage" of any further emergency public-works program.

Out of the four billions, actual check payments to the end of October totaled $1,100,645,560. Of this sum, $312,000,000 were spent on works projects, with leading items as follows:

CCC	$228,912,413
WPA state organizations	46,035,470
PWA non-federal projects	11,260,559
Corps of Engineers projects	10,709,977
PWA housing	6,649,587
Reclamation Bureau	1,979,143
Yards and Docks, Navy	1,766,431

The difference between 300 and 1,100 millions is accounted for by relief, administrative expense, and miscellaneous.

Book Reviews and Notes

A monthly Commentary on Current Additions to the Civil Engineer's Library

Public Works as an Equalizer

PUBLIC WORKS IN PROSPERITY AND DEPRESSION—By Arthur D. Gayer. Cloth; 6x9 in.; pp. 445; 100 tables, 3 charts. Published by National Bureau of Economic Research, New York. $3.

A STUDY OF PUBLIC WORKS and their relation to the nation's economic system was undertaken by the author in 1930, but the results were not published. Later the National Planning Board engaged the author to bring this report up to date. The present volume is the result. It represents source material of fundamental value. Unfortunately, the discussion is mainly directed at statistical detail rather than to the meaning of the figures. In discussing possibilities of public works as a balancing device, the author comes to no conclusion, but says that the decision depends, in the last analysis, on the theory one has of the fundamental nature of the business cycle. More helpful is the statement that experience has demonstrated long-range advance planning and budgeting to be essential to success. One specific conclusion, "that public works should as far as possible be concentrated in periods of depression," apparently disregards the fact that public construction, after all, is an essential service of continuously developing community needs.

Timber Construction Manual

WOOD HANDBOOK—Prepared by Forest Products Laboratory, U. S. Dept. of Agriculture. Paper; 6x9 in.; pp. 325; tables, diagrams, photographs. For sale by Superintendent of Documents, Washington, D. C. 25c.

MORE USEFUL INFORMATION on wood and its engineering applications is brought together in this handbook than in any other single place. In combination with the recent publication of the National Lumber Manufacturers' Association "Wood Structural Design Data" (*ENR*, March 23, 1935, p. 460), it should give the engineer all the information that he needs to design timber structures superior to any of the past. In its 306 pages the manual briefly summarizes the findings of years of research by the Forest Products Laboratory. It devotes special attention to timber fastenings, including the latest data from tests of nails, screws, bolts, spikes, and plate and ring connectors. The bolt data afford a new basis for accuracy in framing timber joints of all sizes at any angle with the grain. Distinctly modern fields of use are covered in the sections on glued-wood construction, plywood, bent members, laminated units, solid and built-up beams, columns and arches. A practical problem that has caused much trouble to designers and estimators is simplified in the treatment of grades and sizes of lumber and structural timbers, to the end that commercial grading rules may be read intelligently and specifications written to obtain hardwood or softwood material that the trade can supply. Proper treatment of wood for fire resistance, control of decay and insect damage is discussed.

Relation of Income to Economic Progress

INCOME AND ECONOMIC PROGRESS—Last of a series of four books on the "Distribution of Wealth and Income in Relation to Economic Progress." By Harold G. Moulton. Cloth; 5½x8 in.; pp. 191. Published by the Brookings Institution, Washington, D. C. $2.

FOUR VOLUMES, of which the concluding one, "Income and Economic Progress," has just appeared, contain the results of an investigation of the workings of our industrial and business system in relation to prosperity and depression. The entire study is of such importance that everyone who is interested in the problems of our times should read at least this fourth volume.

The 1929 collapse led to many opinions as to its causes. One is that the nation's producing plant had been so overdeveloped that we suffered from overproduction. But the fact, as given in the first volume, "America's Capacity to Produce," is that our productive plant was operated during the 20's at a closely uniform percentage of capacity, 80 or 85 per cent, and that about the same margin of productive capacity has existed for a long time past.

Another opinion is that we suffered from underconsumption. The second volume, "America's Capacity to Consume," shows that even in the busiest and most prosperous period the reasonable requirements or wants of the people were far from satisfied. Had the lower 70 per cent of the population in 1929 received an average family income of $2,500 our productive capacity would have been overtaxed. In fact, however, during the prosperous years an increasingly large proportion of the national income was saved instead of spent.

The transformation of savings into productive capital was studied in the third volume, "The Formation of Capital," with the significant conclusion that the growth of capital depends on an expanding demand for consumption goods, and comes to a stop when consumptive demand is declining. Capital formation is not determined by the amount of investment money available.

In the present volume it is shown that foreign markets do not offer a permanent solution of the problem of excess productive capacity; that the country has *not* been living beyond its means or on too high a plane; that a 30-hour week would set us back permanently to 1919 living standards; that we are not at all in a condition of economic old age, but have unlimited progress in living standards and production ahead of us; that wealth equalization could not help to solve the problem; that income equalization would, on 1929 levels, bring us only to about $2,500 per family, which "is not adequate to provide the necessities and comforts requisite for a satisfactory standard of life"; and that increased production is the only effective way of improving our economic level.

The book concludes: "There is one type of distributive reform which outranks all others: the gradual but persistent revamping of price policy so as to pass on the benefits of technological progress to consumers. . . . To seek the acceleration of economic progress by means of price reduction is not to attack the system of private capitalism, but rather to return to the very logic upon which that system was justified. . . . We cannot have the economics of mass production save in an economy of mass consumption. . . . This general proposition today presents an open challenge to the business men of America."

Quality of Water

QUALITIES DE L'EAU ET MOYENS DE CORRECTION—By Ed. Imbeaux. Paper; 8x11 in.; pp. 834. Photographs and drawings. Published by Dunod, 92, Rue Bonaparte, Paris, France.

Reviewed by Francis F. Longley
Vice-President, Lock Joint Pipe Co., Ampere, N. J.

IT IS NOT OFTEN that we have an opportunity to see a phase of engineering extensively compared from the international point of view. In the above work by Edouard Imbeaux, we are afforded a most interesting opportunity to see this broad subject set forth not only as our practice goes in the United States but also in France, England, Germany and various other parts of the world.

Dr. Imbeaux is professor of applied hydrology of L'Ecole des Ponts et Chaussées, of France, and is a member of the Supreme Council of Public Health of France. As advisor to the Minister of War of France in matters pertaining to water supply, a responsi-

bility which he held during the war and which he still holds, he is well known to many Americans who dealt in water-supply problems with the A.E.F.

Dr. Imbeaux' earlier books on water supply, which include "Annuaire Statistique et Descriptif des Distributions d'Eau et Egouts" and "Essai d'Hydrogéologie," are classics. Now comes this new one on the quality of water and the means of correction.

In his efforts to present, for the benefit of French readers, the best experience in connection with American water-supply work, the author has included much information which has long been everyday knowledge to American waterworks engineers. The interest which American engineers will find in this book is, therefore, chiefly in the extensive compilation of information of similar material from sources outside the United States and not commonly found in our literature.

In that section of the book dealing with the methods of analyzing water, there is opportunity for a comparison of numerous different methods in use in different countries. The author's purpose does not seem to have been to make comparisons, since comparative results of different methods are not given, but in setting forth these numerous methods he has done a useful service to those who wish to make comparative studies of the suitability and efficiency of different methods.

In American technical literature, different features of the water-supply problem are largely dealt with under separate cover by different authors whose work has led them to specialize in their respective fields. Here, however, we find the biology phase of the problem dealt with under the same cover with the chemistry and the engineering phases of water-supply work.

Likewise, our literature has dealt with the water-supply problem mainly from the point of view of public water supplies. The author, located in a part of the world where mineral water and mineral baths have for long been an important factor, devotes a considerable part of his volume to a discussion of this phase of the water-supply problem.

The author describes a large number of proprietary filters. The extent and variety of this development in Europe is interesting. On the other hand, from the earliest days of the important development of water-purification plants in this country, engineers in the employ of municipalities have studied the characteristics of their problems, have recognized a certain few elements as basic, have attacked these basic elements scientifically, and then, most important of all, have exchanged views freely, have coordinated and unified their conclusions, and have made all this information public property to the great and lasting advantage of the country. Even those industries which specialize in the business of building water-purification plants have been ponderously influenced by this policy and conform closely to it, so that their business today consists more in the furnishing of the special mechanical appliances needed in a filtration plant of conventional engineering design than it does in furnishing the entire plant as a ready-made mechanical unit.

On the whole, this work of Dr. Imbeaux' presents a most interesting opportunity for students of the water-supply problem to study the art as it is practiced in many parts of the world.

Miscellaneous Notes on Booklets and Reprints

HYDRAULIC LABORATORY RESEARCH in progress throughout the country is reported in Bulletin No. VI-6, National Bureau of Standards, Washington, D. C.

STANDARD DIMENSIONS FOR BUILDING BRICK have been issued by the Canadian Engineering Standards Association, Ottawa, Ont., Canada. Price, 25c.

"TAX-PAYING AND TAX-SPENDING TRANSPORTATION" is the title of a pamphlet put out by the Association of American Railroads, Washington, D. C.

"HORIZONTAL THRUST FOR TWO-HINGED ARCHES OF VARIOUS FORMS" is the title of Bulletin 148, Faculty of Applied Science and Engineering, School of Engineering Research, University of Toronto, Canada.

LABORATORY TESTS on three-span reinforced-concrete arch bridges with decks on slender piers, an investigation conducted jointly by the Engineering Experiment Station of the University of Illinois and the United States Bureau of Public Roads, are described in Bulletin No. 270 of the Experiment Station, Urbana, Ill. Price, $1.

New Books and Revised Editions

[Those desiring copies of the books listed below or mentioned elsewhere in this section should order them from the publishers or from their local booksellers.]

PUBLIC LAND SURVEYS, History, Instruction, Methods—By Lowell O. Stewart. Cloth, 6x9 in., pp. 200. Published by Collegiate Press, Inc., Ames, Iowa. $2.25.

MODERN SURVEYING FOR CIVIL ENGINEERS—By H. F. Birchal. Cloth, 6x9 in., pp.524, numerous line cuts and halftone illustrations. Published by Chapman & Hall, Ltd., London, England. Price, 25 shillings.

PREPARATION OF ENGINEERING REPORTS—By Thomas R. Agg and Walter L. Foster. Cloth, 5x7½ in., pp. 192, numerous diagrams and charts. Published by the McGraw-Hill Book Co., New York and London. Price, $1.75.

CARTEL PROBLEMS, An analysis of Collective Monopolies in Europe with American Application—By Karl Pribram. Cloth, 5½x8¼ in., pp. 287. Published by The Brookings Institution, Washington, D. C. Price, $2.50.

ECONOMICS OF TRANSPORTATION—By D. Philip Locklin. Cloth, 6x9 in., pp. 788, numerous maps and charts. Published by the Business Publications, Inc., Chicago, Ill. Price, $4.

RAILWAY AND HIGHWAY TRANSPORTATION ABROAD, A Study of Existing Relationships, Recent Competitive Measures and Coordination Policies—By W. Rodney Long. Paper, 6x9 in., pp. 426. Published by the Bureau of Foreign and Domestic Commerce, U. S. Dept. of Commerce. For sale by the Superintendent of Documents, Washington, D. C. Price, 50c.

STEEL PLATES—Fabrikold, 6x9 in., pp. 361, numerous tables, linecuts and halftone illustrations. Published as Catalogue 132 by the Bethlehem Steel Co., Bethlehem, Pa. Price, $1. . . . *Information and tables concerning plates and plate products, properties of pipe, conversion tables, standard shapes, etc.*

THEORY OF FLOW OF WATER AND HYDRAULICS OF RIVERS AND CANALS— By Radha Krishna Khanna. Cloth, 6½x10 in., pp. 168, four sheets of diagrams. Published by Rama Krishna & Sons, Lahore, India. Price £1/1.

INDUSTRIAL ARCHITECTURE — Edited by C. G. Holme, introduction by L. H. Bucknell. Cloth, 9x11¾ in., pp. 208, halftone illustrations with explanatory captions. Published by The Studio Ltd., London, and The Studio Publications Inc., New York. Price $10.

TRAFFIC AND TRADE, An Introduction to the Analysis of the Relationship between the Daily Habitual Movement of People and Their Trade Activities in Markets—By John Paver and Miller McClintock. Cloth, 9x12 in., pp. 137, numerous maps and charts. Published by the McGraw-Hill Book Co., New York and London. Price, $4.50.

SEEHAFENBAU, Band III Besondere Hafenbauwerke. By F. W. Otto Schulze. Paper, 7x9½ in., pp. 304. Numerous linecuts. Published by Wilhelm Ernst & Sohn, Berlin, Germany. Price (paper) 4,60 RM.

PFEILER UND WIDERLAGER VON BRUCKEN—By Dr.-Ing. K. Schaechterle. Paper, 7x9¼ in., pp. 207, numerous linecut and halftone illustration. Published by Wilhelm Ernst & Sohn, Berlin, Germany. Price, (paper) 14 RM.

TECHNOKRATIE WELTWIRTSCHAFTSKRISE, und ihre endgültige Beseitigung —By Karl Resar. Paper 6x8 in., pp. 203. Published by C. Barth, Vienna, Austria.

AIRCRAFT, The New Vision—By Le Corbusier. Cloth, 7x10 in., pp. 100. Chiefly illustrations. Published by The Studio Ltd., London, and The Studio Publications Inc., New York. Price, $2.50. . . . *An architect's attempt to show how the new vision of our cities given us by the airplane must affect all our town and city planning.*

VERSUCHE IM STAHLBAU — Heft 5, Dauerversuche mit Nietverbindungen—By Otto Graf. Paper; 8x11 in.; pp. 50; diagrams, tables. Published by Julius Springer, Berlin, Germany. RM 4.50.

ONDES DE TRANSLATION—Dans les Canaux Découverts—By Henry Favre. Paper; 6x9 in.; pp. 215; diagrams, tables, photographs. Published by Dunod, Paris, France.

MANUAL ON PRESERVATIVE TREATMENT OF WOOD BY PRESSURE—By J. D. MacLean. Paper; 6x9 in.; pp. 124; diagrams, formulas. For sale by Superintendent of Documents, Washington, D. C. 15c.

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Revision Is Progress

REVISIONS recently made by the New Jersey state health department in requirements for design and operation of sprinkling filters illustrate the spirit with which authorities throughout the country are alertly keeping pace with the rapid development of sewage treatment. The new regulations are quite specific in stating exact limitations of loadings and design, and this precision in forecasting results reflects and applies the advances that have been made in the last decade. It is also of interest to note that further evaluation of sprinkling-filter performance has been made despite the many assertions, several years ago, that this method of secondary sewage purification was doomed by the introduction of the activated-sludge process. Enthusiasm for new processes sometimes causes abandonment of the older methods before their full possibilities have been investigated. Revision that recognizes the value of established methods is a mark of wisely guided progress.

Water Funds Next

ARE WATER UTILITIES to be made the stepchild of municipal administration? A recent Philadelphia proposal to borrow $6,000,000 on the debt-free water system to finance subway and flood-prevention work clearly suggests this hazard. There is real danger that the practice of robbing road funds for general expense and other purposes which has become common during the last few years will now be extended in wholesale manner to water-service funds, for the Philadelphia case, while latest and largest, is by no means the only example of tapping the till of water departments. Is it sound practice to commandeer water revenues simply because the management of the department has been able to meet its obligations and build up a substantial credit rating? Philadelphia will shortly have to undertake elaborate extension of its waterworks system and it will then need all the credit that its good management has earned. The only way in which a vital service of this kind can be kept continuously sound is to make its bookkeeping and finances self-contained and rigidly respect the independence of its funds.

Stabilized-Soil Bases

SEARCH for methods of stabilizing soil subgrades for road surfaces is persistent. Deliquescent salts, bitumens and hydraulic cement have all had trial during the last two years in both laboratory and field experiments. The latest of these, reported for the first time in this issue, are the portland-cement-stabilized soil experiments in South Carolina. The findings indicate substantial success in cementation. It is made quite clear also that the process should be regarded as a method of base construction requiring protection by a wearing surface of standard construction. In South Carolina the adopted wearing surfaces have been of bituminous type. By the stress that has been laid on stabilized soil as surfacing we have come to overlook its usefulness as a foundation, whose strength will make the wearing surfaces more durable; the South Carolina experiments are helpful in recalling this fact to the mind of roadbuilders. It is being found in other states that previously stabilized surfaces are a preparation for other surfacing rather than adequate roads in themselves. In this new capacity, soil stabilization offers a far more convincing possibility than its records as a surfacing material have demonstrated, and some of these records have been excellent.

Defend the Frontier

IT IS AN AXIOM that the primary obligation of a nation is to defend its frontier. In our case the frontier is constantly menaced by the attack of the sea, yet the nation has done nothing to organize for defense. When sudden ravage occurs, as in the North Atlantic coast storm of the past fortnight, it holds attention for a day and then is forgotten, without thought of doing anything to prevent its recurrence. And this for natural reasons: the coast is remote from most of us, and the damage is done on another man's land. Yet the ceaseless wearing and change of the coasts is of no less public concern than the wasting of farm soil or the dissipation of our water resources. Some consciousness of the importance of coast defense has lately begun to evolve; the inclusion of shore protection in the Works Act, even though it led to no result, was a sign of this awakening. But there is need for stronger convictions, of a kind that will lead to action, for the states and local residents are not the only parties at interest in coast preservation. The nation shares in interest, and in due proportion should join in protection.

Statewide Water Management

SHOULD DOUBT EXIST anywhere as to the urgency of comprehensive water planning on a statewide or regional basis, current discussions and disputes in New Jersey over water problems can supply a decisive answer. Numerous isolated groups there are working actively on local conservation and supply problems, but the absence of broad plan or purpose makes their efforts futile. Differences in both supply and demand conditions between the northern, middle and southern parts of the state contribute to lack of understanding, and personal and political ambition has for years stood in the way of any harmonious, purposeful attack on the problem. The State Water Policy Commission, a laudable attempt to reform the situation, has never been granted either the powers or the funds necessary. Meanwhile supply possibilities are being dissipated by local fractional exploitation. Were a strong central authority set up, it could do much to assure the future growth of the state. A like possibility, it might be added, exists also in most other states, for nearly everywhere the adequacy of water resources is approaching a dangerous state. Comprehensive water planning is definitely one of our great and urgent public obligations.

Safety Through Engineering

CONSCIOUSNESS of the hazard of the highway to human life is beginning to bear heavily on highway interests. Safety of the road was the most actively discussed subject at the recent convention of the American Automobile Association; it surpassed in interest even the increase in gasoline taxes, so long the favorite target of this useful organization. Again, at three coming meetings of state

highway officials the subject of safety is to be the main item of discussion. Such widespread concern brings encouragement; it forecasts an engineerig approach to the analysis of highway safety, which is something that has long been needed. The undeniable truth is that the highway is dangerous—the most dangerous of all the structures that engineers have designed and constructed for the service of man. No purpose is served by holding up speed and careless driving as prime objects of censure, for, whatever may be the sins of the motor vehicle and its operatives, the fact remains that the modern road does not permit of safe driving; the average improved highway offers hazards to any driver, at any speed greater than the crawl of the horse and buggy. Except for solidity and reasonable smoothness of surface, it exhibits gross faults of design and structure on every hand. Highway engineers know these faults, and know how to correct them, but they have been remiss in the matter of convincing others of what they know about safe alignment and road structure. If the awakened interest in the dangers of highway travel leads to future direct action, a long step toward the safe highway will have been taken.

Battles Recalled

GHOSTS of bygone days are evoked by a news item which reports that $59,598 of relief-works money has been allotted to survey a highway along the line of the old South Penn Railway. That interesting undertaking of the buccaneer days of American railroading was begun in 1883, after years of efforts by various promoters to build a railway from Harrisburg to Pittsburgh, Pa. It ranked as one of the most costly projects of the eastern United States and of the boom years of the eighties, when the railway empire of America was adding yearly from 5,000 to 13,000 miles of new line to its possessions. Connecting with the Philadelphia & Reading R.R. at Harrisburg, the new project threatened to divert from the Pennsylvania R.R. a share of the rich traffic from the Ohio to the seaboard.

The enterprise had striking characteristics. The financing was unusually sound; steel and oil capital from western Pennsylvania joined with New York railway capital allied with the Vanderbilt interests. A double-track railway was planned for the entire 213 miles—a bold thing for those times, when a single track was all that was commonly ventured in new-line construction. But almost as bold an innovation was carried out in line location; instead of seeking the valleys and lowlands of watercourses as had been and was the practice of all railways penetrating the Appalachians, the South Penn engineers sought a route high up along the ridges. This location involved some nine tunnels, but virtually eliminated expensive bridges and required no grades exceeding 2 per cent and no curves sharper than 6 deg. Perhaps some explanation of this nice accomplishment may be found in the names of the engineers, Robert H. Sayre and William F. Shunk.

Construction was begun under a number of contracts, all the tunnels were built, and about a quarter of the grading was completed. But with the South Penn grading well advanced, another force, equally characteristic of the railroading of those days, entered the field The Pennsylvania R.R., whose line was paralleled struck back by beginning construction on the west shore of the Hudson River of a railway paralleling the Vanderbilts' New York Central line to Albany. This presaged a war that vested railroad interests did not wish, and a compromise was effected by the elder J. P. Morgan, which resulted in the withdrawal of both forces from the rival fields.

So the South Penn Railway was abandoned. What remains of it is planned for re-use by an agency of transportation beyond the contemplation of the old railway picaroons who battled during the last two decades of the eighteen hundreds for control of transportation territory.

The Works Program Fails

BY THIS TIME the fact that the four-billion-dollar works program has been converted into a colossal failure is patent to everyone. No restatement of facts is necessary. Nevertheless, a summary such as that printed on page 754 of this issue is useful in calling to mind some of the events that led up to present result.

Briefly, at the deadline date of the program only a fraction of the intended employment has been produced. The 3½ million men who were to be re-employed by this time have shrunk to barely one-third as many—the official figures must be discarded as deceptions, since they include pre-existing CCC and ERA employment, which is not the additional employment intended. And further, in place of a constructive public-works undertaking we have a new CWA system with the defects and vices of the earlier system multiplied.

Back of this disheartening outcome of an undertaking in which everyone had high hopes are causes that have been plainly manifest for months. There were long weeks of delay in organizing and finally a system of administration apparently designed to breed conflict and stop progress rather than to bring quick results. Principle and purpose were lacking. Rules that were necessary to make country-wide cooperation effective were long withheld and later were subject to arbitrary change. PWA work was discouraged and restricted at every point. Highway construction, readiest employment-creating activity at hand, was delayed so long that the working season was wasted. There were disorganizing changes in pay scales and hours. Throughout, the government's own promises were broken, the intent of Congress as expressed in the Act was disregarded, and the cooperation of public officials the country over was flouted.

Yet, though the present four-billion-dollar works program has failed, the public-works plan of fighting depression has not failed. It remains the strongest weapon we have against the calamity of general unemployment. Productive work will always be preferable to home-relief charity, and useful labor which produces enduring results is better for both individual and community than enforced idleness. Making these truths effective in practical application by a planned program is in no way beyond the bounds of present experience and skill.

These are facts that cannot be shaken by the failure made at Washington. They make it certain that so long as the effects of the great depression survive in the form of unemployment, next year as well as this, our salvation will lie in well-planned, constructive work—directed not by welfare workers but by men experienced in engineering and construction management.

CURRENT NEWS

Mississippi River Bridge Opened to Traffic

The suspension bridge across the Mississippi River from Bettendorf, Iowa, to Moline, Ill., was opened to traffic on Nov. 19. The density of traffic during the first 24 hours of the bridge's operation indicated that there would be sufficient traffic so that there would be no difficulty in obtaining revenue for the retirement of the bridge bonds. It has been estimated that only 8 per cent of the average traffic that crosses on the government bridge from Rock Island to Davenport would be needed to assure financial success for the new bridge.

The bridge, which is being built as a public toll structure by the Davenport Bridge Commission and financed with PWA funds to the extent of $1,750,000, has an overall length of 5,552 ft. The main suspension span is 740 ft. and the side spans each 370 ft. (*ENR*, Sept. 19, 1935, p. 415). Sixty feet of clearance above high water is available. This is the first suspension bridge to span the Mississippi River below Prairie du Chien, Wis. Proposals to continue the extension of U. S. Highway No. 6 through the northern part of the city of Davenport to the new Iowa-Illinois bridge are being made.

Modjeski, Masters & Case, Inc., were the engineers on the bridge with W. C. Gorman, resident engineer. Kansas City Bridge Co. built the substructure while McClintic-Marshall Corp. did the superstructure work.

Hudson River Deepening Held Dangerous to Tunnels

At a hearing held by Col. John W. N. Schulz, district engineer, U. S. Army, New York City, on Nov. 22, to discuss deepening of the Hudson River, it was pointed out that deepening of the river might be dangerous for the railroad and vehicle tunnels between New York and New Jersey.

The Maritime Association petitioned that the harbor channels in the Hudson River, as far up as 60th St., be deepened to 50 ft. to reduce the danger to large ships. It was held that the navigation of the larger ships in the river is dangerous under existing conditions. The present channel is 40 ft. deep, while the draft of some of the larger ships, such as the Normandie, is 39 ft. Because of this very small margin of clearance, a number of ships have been delayed in getting away from port.

Opposition to the deepening of the river was expressed by various railroad companies and the Port of New York Authority. Spokesmen for the Hudson & Manhattan R.R. Co. contended that removal of material from the top of the river tunnels might allow them to rise from their present bases and thereby endanger them. The Port Authority desired more information as to the possible effect of the river deepening on the tunnels before it would express a final opinion.

Arizona Renews Litigation Over Colorado River Water

Arizona has revived its attack on the apportionment of Colorado River waters under the contract among the basin states. Reports current for several months past that Arizona would contest the claims of California, Colorado, Nevada, New Mexico, Utah and Wyoming culminated Nov. 25 when the state, through its attorney general, asked permission from the U. S. Supreme Court to file suit for a fair apportionment.

Rural Electrification Program Amplified by M. L. Cooke

Federal support of a long-range comprehensive program to bring electricity to at least half of the farms in the United States is economically and socially justifiable, states Morris L. Cooke, Rural Electrification Administrator, in a letter to Senator George W. Norris of Nebraska amplifying his earlier letter (*ENR*, Nov. 7, p. 656). This result could be accomplished in ten years, he estimates, at a cost of about $1,500,000,000 of which at least one-third should eventually be self-supporting.

Mr. Cooke's letter is a reply to a request of the Senator's asking what would be involved in extending power lines to a much larger percentage of rural homes than are now supplied with current, how soon this could be brought about, and whether, in the Administrator's judgment, a subsidy would be justified to put such a program into effect.

Mr. Cooke's reply points out that electric power has become a social necessity and should be available in "any area where costs would not be prohibitive and the prospective use would be sufficiently large."

Studies by the Rural Electrification Administration indicates that the present limitation of service to approximately 11 per cent of the nation's farms is due to the following factors: (1) prohibitive costs of line construction; (2) excessive demands for cash contributions for building lines; (3) high rates which discourage the abundant use of current; (4) the policy of extending monopolistic franchises as widely as possible while extending actual services only to the more profitable areas. Much of REA's planning has been directed toward demonstrating that the costs of rural service can be lowered by planning extensions to serve entire areas to secure the economies of mass production; by building lines by contract after competitive bidding; by lowering overhead and capital charges; by encouraging rates that promote abundant consumption, and by furnishing reasonable terms for the purchase of appliances.

While the attainment of these objectives would more than double the rural territory that could be served on a self-liquidating basis, it would still leave three-quarters of the farm population without power service.

Approval Withheld By PWA On Buffalo Sewer Engineer

THE Buffalo, N. Y., Sewer Authority at a meeting Nov. 22 invited the engineering firms of Greeley & Hansen, Chicago; Whitman, Requardt & Smith, Baltimore, and Metcalf & Eddy, Boston, to send representatives to a meeting held Nov. 25 at which time consideration was to be given to the appointment of an engineer to succeed Clyde Potts, New York, who had been retained on Nov. 13, but who failed to receive necessary approval by PWA. The meeting of Nov. 25 was devoted to formulating a revised contract and no engineer was appointed. An original contract for which negotiations had been carried on with Fuller & McClintock of New York and rejected on Nov. 13, was again rejected by the Authority, which must have the project under contract by Dec. 15.

Of the three firms now under consideration, Metcalf & Eddy had previously submitted a blanket fee proposal for the design and supervision of the Buffalo sewage disposal plant and sewerage improvements. This proposal, calling for 3½ per cent for design and ¾ of 1 per cent for supervision, made in accordance with the American Society of Civil Engineers' fee recommendation, was originally rejected by the Authority as being too high.

The disapproval of the contract with Clyde Potts came on Nov. 21, following protests, made by a large number of business, civic and political organizations, to Administrator Harold Ickes. Mr. Potts is reported to have informed the authority that he is prepared to take legal proceedings to protect the contract he signed.

Favorable Report Submitted On Santee-Cooper Project

A favorable report on the Santee-Cooper hydroelectric project in South Carolina has been submitted to PWA Administrator Ickes by a special board of engineers. As President Roosevelt already has signified his approval there is little doubt that an allotment of work relief funds will be made to initiate construction. A loan and grant of $500,000 for preliminary work has already been made to the South Carolina Public Service Authority (*ENR*, Oct. 3, 1935, p. 481).

The cost of the project is estimated at $37,500,000. As the engineers' report has not been made public, it is not known whether the exact site of the dam has been selected but it will be located on the Cooper River near Pinopolis and divert water from Santee River into Cooper River near Manning. The project involves reopening of the old canal between the two streams built by slave labor in 1798. Annual generation of power is estimated at 630,000,000 kwh.

Construction Economics Section In Department of Commerce

A new unit, known as the Construction Economics Section, has been established in the Bureau of Foreign and Domestic Commerce, Department of Commerce, to engage in economic research of the business problems of the construction industry. One of the functions of the new unit will be to make available the information collected by the Real Property Inventory and the Financial Survey of Urban Housing sponsored by the Bureau of Foreign and Domestic Commerce in 1934. Since, however, economic research in the field of housing and public construction has been undertaken by a number of federal agencies, no new work is contemplated in this connection. The new Construction Economics Section will give special attention to the economic factors relating to private construction other than housing, such as commercial and industrial building construction; the financing of such construction; business problems of construction work, and of the manufacture and distribution of materials and equipment, and to similar problems relating to the construction industry.

For the present fiscal year the work will be somewhat limited. Investigations will be started, however, in studies of the fluctuations in construction of commercial and industrial building in relation to interest rates, technological improvements, rate of industrial production, obsolescence and deterioration of structures and other items affecting the industry.

Four Large Incinerators Projected at Detroit

Bids for four combined garbage and refuse incinerators with a total capacity of 1,400 tons a day have been invited for Dec. 4 by Wayne County, Mich. All the plants are to be located in Detroit, as a PWA project. The capacities of the plants are 450, two 350 and one of 250 tons. Bidders must submit plans and specifications in compliance with the county's general plans and specifications.

No furnace will be considered acceptable unless one of the same kind has "successfully and without nuisance incinerated in one unit at least 100 tons of mixed refuse having a mixture of 65 per cent garbage and 35 per cent rubbish containing 50 per cent moisture, without the use of additional fuel." The moisture of the green garbage shall be taken as 70 per cent, that of rubbish as 13 per cent, and the corresponding heat values as 1,400 and 6,500 B.t.u. Bids will be compared on the basis of (a) bid price, (b) man hours of labor per ton and (c) kilowatt-hours per ton for all equipment.

John C. Cowan is chairman and Lawrence G. Lenhart is consulting engineer of the Board of County Auditors of Wayne County. Mr. Lenhart is also commissioner of public works of the city of Detroit.

Three years ago Detroit invited bids for building, financing and operating four incinerators, bidders to name the price per ton of material burned under a plan by which the plants would become the property of the city in seven years without further payment. (*ENR*, Feb. 9, 1933.) No bids were received, due it was said to the disturbed financial condition of the city at that time.

CABLE SPINNING BEGUN AT GOLDEN GATE BRIDGE

Spinning of the two 36-in. diameter cables of the Golden Gate Bridge at San Francisco has begun. A departure from the usual procedure in which the haulage rope operates from anchorage to anchorage will be followed. Midway of the 4,200-ft. main span the bridge wires will be transferred from one spinning wheel to another; each wheel travels only from the anchorage to mid-span and return. Cable spinning is scheduled for completion in August, 1936. The cable contract is held by the John A. Roebling's Sons Co., Trenton, N. J. The photograph was taken during the preparations for cable spinning.

Disposal Equipment Case Dismissed by Court

Finding no merit in the contention of Filtration Engineers, Inc., Newark, N. J., that the specifications for vacuum filter equipment for the new District of Columbia sewage disposal plant were unduly restrictive, the Supreme Court of the District of Columbia has dismissed the case.

The suit was brought Sept. 30 charging that the specifications restricted bidders to the use of vacuum filters with scraper removal of sludge deposits, thus eliminating the patented spring discharge of the complainant from consideration (*ENR*, Oct. 17, 1935, p. 555). Bids were received on Oct. 1 from four general contractors, but award of the contract was held up pending the disposition of the suit. Engineers for the district stated that the specifications had been drawn up after full consideration of all available types of equipment, and that the spring discharge device was not considered satisfactory for conditions at the new plant.

Metcalf & Eddy, Boston, are consulting engineers for the work.

Extensive Highway Program Suggested for Mississippi

It is expected that the Mississippi legislature will give serious consideration to an act tentatively approved by a committee, and providing for a $46,000,000 road paving program substitued for the proposal offered by the Citizen's Highway Association.

The new bill calls for a PWA loan and grant of $36,000,000 and the pledging of state gas tax funds for repayment of the $19,800,000 loan portion of the fund by the state. Additional federal aid funds will boost the amount available to about $46,000,000. The only difference between the two bills is that the substitute vests full administrative authority over the proposed 1,737-mi. main highway paving program in the state highway department. The citizen's bill had proposed a separate agency of five members. The citizen's proposal also called for administration of the program by an Army engineer.

The bill outlines for immediate paving all main U. S. marked highways; Mississippi Highway No. 15 from New Albany through Newton and Laurel to the Alabama line near Waynesboro; state highway from Columbia to Hattiesburg; two state highways connecting both ends of U. S. Route 45 and state highway from Oxford west to U. S. Route 51.

The bill creates a state highway board composed of the governor, attorney general and state treasurer, which upon request of the state highway commission may issue bonds of $19,800,000 for financing the program, and apply for PWA funds of $36,000,000, of which $16,200,000 is to be a direct grant. Two other road measures, designed to permit the state and counties to cooperate in the Natchez Trace Parkway paving program of the federal government have been approved by house committees, as was a bill permitting cities to issue revenue bonds for construction of toll bridges. This bill is to permit Natchez to issue $2,500,000 in bonds for a bridge over the Mississippi River.

Funds are to be put in a special fund and expended solely on roads designated in bill.

Work on Wheeler Dam Up to Schedule

Work on the Wheeler Dam of the Tennessee Valley Authority is progressing on schedule although construction was hampered for a short time by low water that hindered the delivery of concrete materials. The highway bridge is more than half completed except for side railings. The first of 60 radial steel flood gates, 40 by 14 ft., is being assembled and installed. About 2,500 men are employed.

Erection of the first 45,000 hp. turbine has started and the contract for an additional similar unit has been awarded.

James W. Rollins Dies, Was Prominent Eastern Contractor

James Wingate Rollins, Jr., vice-president of the Blakeslee Rollins Corp. of Boston, and prominent in heavy construction work in the East since the close of the last century, died at his home in Milton, Mass., in suburban Boston on Nov. 19 at the age of 77. He was born in Boston in 1858. For nearly twenty years after his graduation from Massachusetts Institute of Technology in 1878, Mr. Rollins was associated

James Wingate Rollins, Jr.

with several railroads as an engineer, including the Massachusetts Central, Atlantic and Danville, Union Pacific, Adirondack, New Haven, and Plymouth & Middleboro lines.

In 1896 Mr. Rollins joined the firm of Holbrook, Cabot & Daly, general contractors of Boston, and became president of the Holbrook, Cabot & Rollins Corp. in 1904, a position he held until the dissolution of the firm in 1924. From 1924 until his death he was an official of the Blakeslee Rollins Corp. As a contractor Mr. Rollins built numerous bridges, dams and hydroelectric projects in New England. A wet dock at the Boston Navy Yard, a dry dock at the Brooklyn Navy Yard and the Boston Fish Pier represent some of the heavier works he built before the war. His war time projects include a part of Hog Island shipyard at Philadelphia, the Boston Army supply base, the New Orleans army supply base, and the Times Square section of the present B.-M.T. subway system in New York. Upon the completion of this last contract, started in 1915, Mr. Rollins and other contractors engaged upon similar work at the time, filed huge claims against the city to recover increased costs occasioned by the war. All of these claims were finally compromised out of court.

In later years Mr. Rollins twice came into national prominence through his connection with two spectacular construction projects, the Passaic Valley sewer and the Mid Hudson bridge piers. In 1922 his firm undertook the completion of 6,000 ft. of tunnel remaining for the Passaic Valley Outfall Sewer in New Jersey after two other contractors had given up. After a year's work Holbrook, Cabot & Rollins abandoned the work because of construction difficulties and the tunnel was finally finished by Charles A. Haskins at a considerable loss. In 1924 the Rollins firm won a suit for $816,600 against the Passaic Valley Sewerage Commission based on claims of deliberate misrepresentation of borings and other engineering information (ENR July 3, 1924, p. 21). This suit was the first intimation Haskins had of fraud, and subsequently he won a suit for $612,566 based on the same claims.

On the night of July 25, 1927, the 19,000-ton concrete open caisson being sunk for the last pier of the Mid Hudson bridge at Poughkeepsie tipped over to an angle of 42½ deg. from the vertical. The caisson was finally righted after a year's effort (ENR Feb. 21, 1931, p. 275). The contractor claimed the caisson was improperly designed, and sued the state for damages aggregating $356,250. The state claimed that the contractor was careless in dredging out the pockets of the caisson, and successfully defeated the suit.

The last large job completed by the Blakeslee Rollins Corp. was the piers for the new railroad bridge over Cape Cod Canal. The contractor chose to build the piers within cofferdams rather than to use pneumatic caissons, and ran into serious difficulties in driving long sheeting through ground containing numerous boulders.

Scheme to Divert Water To Great Lakes Revived

A scheme to divert the headwaters of the Albany and Ogoki Rivers from the Hudson Bay watershed into the Great Lakes watershed, considered by engineers of the Hydro-Electric Power Commission of Ontario in 1924, has been revived by the commission and is to be put up to the Dominion Parliament for consideration in the near future, according to statement made recently by T. Stewart Lyon, chairman of the commission.

The plan calls for damming the Ogoki River at a point where it has a drainage area of approximately 6,000 sq. mi. and diverting a flow averaging 4,000 sec.-ft. across the divide into Lake Nipigon, a large lake lying north of Lake Superior, which would be used as a storage and regulating reservoir.

The Ontario Hydro-Electric Power Commission now has two power developments on the Nipigon River connecting Lake Nipigon with Lake Superior, developing 135 ft. of the total drop of 240 ft. Power plants would be built to develop the remainder of this head and the 210-ft. drop from the divide into Lake Nipigon. Also, the water obtained by the diversion could be used by Canada in addition to the water now used in the international channels at Sault Ste Marie and at Niagara Falls, both of which lie partly in Ontario. With the development of the International section of the St. Lawrence River Ontario also would benefit by the added flow. A total of nearly 400,000 hp. could be developed, according to the estimates of the engineers of the commission.

Recently the commission cancelled its contract to buy power from private utilities in Quebec and is now looking for added sources of hydroelectric power available within the province.

Engineers Study Coordination Of Nebraska Power Projects

A committee of engineers to develop a comprehensive plan for coordination of the three major PWA power projects in Nebraska has been appointed by Administrator Ickes. Collectively the Columbus, Sutherland and Tri-County projects involve an expenditure of $40,000,000. The committee is headed by Dr. Elwood Mead, Commissioner of Reclamation. The other members are J. D. Ross, member of the Securities & Exchange Commission; R. V. L. Wright, consulting engineer for the Wrigley estate; George F. Harley, a member of the Engineering Division of PWA; and K. Sewell Wingfield, Assistant Director, PWA Power Division.

Before leaving Nov. 20 to inspect the projects, the committee reviewed their engineering and financial structure for the purpose of evolving a cooperative plan which will produce the greatest benefit to the public. The committee will return to Washington about Dec. 1 and thereafter submit its report to Administrator Ickes. The projects will retain their individual identity but will be interconnected to permit exchange of power in emergencies and in peak load periods. Of the three projects, Sutherland is almost completed, Columbus about 12 per cent completed, and Tri-County is just getting under way.

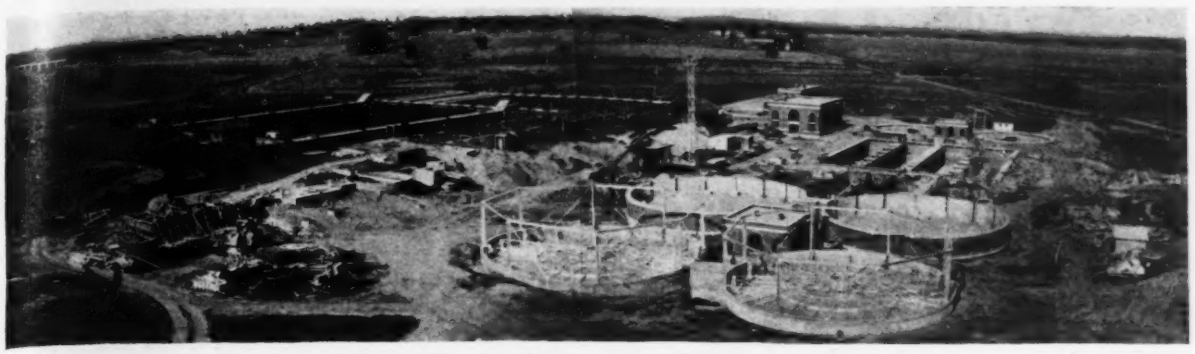
Reclamation Bureau Call Bids On Ogden Canal Construction

The Bureau of Reclamation has called for bids to be received Dec. 20 at Ogden, Utah, for construction of earthworks, canal lining and structures on the Ogden-Brigham Canal, and South Ogden High Line Canal. The work is covered by an allotment of $3,000,000 for the Ogden River project, from old PWA appropriations and $500,000 from relief works funds to cover Pine View Dam, the canal work advertised above and rehabilitation of the Ogden water works.

Principal items in the canal construction include 240,000 cu.yd. of all classes of excavation; 20,000 cu.yd. excavation for structures; 7,700 cu.yd. excavation for drainage channels and dikes; 10,000 station cu.yd. for overhaul; 9,000 cu.yd. of compacted embankment; 1,500 sq.yd. of rock trimming of canal sections for concrete lining; 115,000 sq.yd. of trimming in earth sections; 59,000 cu.yd. of backfill; 4,060 cu.yd. of concrete in structures; 710 cu.yd. of concrete combination section; 9,390 cu.yd. of concrete in canal linings; placing of 1,001,000 lb. of reinforcing bars; laying of 6,295 lin.ft. of 12 to 36 in. concrete pipe; and miscellaneous metal work.

Bids Called on Power Lines

Bids will be received on or about Dec. 1, 1935, by the Ohio Farm Bureau Federation, Columbus, Ohio, for labor and materials to construct 193 mi. of rural distribution line in Miami County and 270 mi. in Shelby County. Estimated costs are: Miami project, $180,000; Shelby project, $250,000. Both projects are being financed through loans made by the Rural Electrification Administration.



NEW ACTIVATED SLUDGE PLANT FOR MADISON, WIS.

The 6½-m.g.d. Nine Springs sewage treatment works of the Madison, Wis., Metropolitan Sewerage District, an addition to the existing 5-m.g.d. Imhoff-tank-and-trickling-filter plant, shown in the left background, is nearing completion. The new plant is a PWA job of the activated sludge type and will operate in parallel with the present one. It includes a grit removal tank, forms for which are shown in the left foreground, grease flotation tank, grease separation tank, which will serve both new and old plants. The activated sludge works comprise two sludge storage tanks with gasholder covers, sludge control building, two sludge digestion tanks with floating covers, two rectangular preliminary settling tanks, aeration control building and two round final clarifier tanks. The blower building in which digester gas will be utilized for power for one of two blower units is shown in the center background and behind it is the service building and a new final clarifier for the present works. Permanent Construction Co. is the general contractor. Greeley and Hansen, Chicago, made the designs. H. O. Lord, is chief engineer and A. M. Trester is resident engineer.

Engineers Urge Concerted Action On Westchester Water Problems

Convinced that Westchester County, New York, will soon be faced with a water shortage unless the several communities unite on a program of water supply improvement, members of the Westchester County Chapter, New York State Society of Professional Engineers, have begun a campaign for the establishment of a Westchester County Water Supply Authority. The campaign is to be inaugurated with a mass meeting in the County Center at White Plains on Dec. 6 with Frank E. Winsor, of the Boston Metropolitan Water District as the principal speaker.

Westchester County is a populous suburban district lying to the north of New York City. Its many municipalities now are served by about 50 water districts, some private and some public, largely independent, most of which draw water from sources that are limited and subject to pollution. The principal nearby sources of additional supply were preempted by New York City in the past. The proposed authority would coordinate water supply planning for the county.

President Williams of Lehigh Honored at New York

Clement C. Williams, the new president of Lehigh University, former dean of the College of Engineering at the University of Iowa, was the guest of honor at a dinner given by the Lehigh Club of New York on Nov. 20. Speakers at the dinner included W. C. Dickerman, president of the American Locomotive Company; P. M. Palmer, director of the College of Arts and Science at Lehigh University; Robert C. Clothier, president of Rutgers University; Arthur M. Greene, Jr., dean, Princeton University; Willard Chevalier, vice-president, McGraw-Hill Publishing Company, and President Williams. President Williams spoke on the impact of social complexity on education, his talk being broadcast.

President Williams received the degree of Doctor of Engineering from Lafayette College at its Founder's Day convocation Nov. 1.

Brief News

FAIRFIELD COUNTY COMMISSIONERS have authorized a $15,000,000 bond issue to finance the construction of the Merritt Parkway through Connecticut, work on which has been under way for some time. The county treasurer, with the authority of the Merritt Parkway Committee, will borrow as much of the $15,000,000 as is required from time to time as construction proceeds. State Highway Commissioner John A. Macdonald has urged an immediate issue of $3,000,000.

AN ALLOTMENT of $3,665,000 to the Procurement Division of the Treasury Department for construction of the so-called Apex Building in Washington has been made by PWA from old appropriations. This building will complete the "Triangle" building program undertaken several years ago to rehouse government departments. It is planned to house the Federal Trade Commission and other governmental agencies in the Apex Building.

INVESTIGATION OF AIR CONDITIONING PROBLEMS in western mines is being undertaken by the Bureau of Mines for the first time. Long hampered through lack of funds in its desire to undertake this work, particularly since air conditioning of mines has not made much headway in this country, the bureau has sent three of its engineers to the Morning Mine at Mullan, Idaho. Owners of the mine cooperated in offering facilities so the study could be made. The bureau hopes to solve any problems of mine air conditioning its engineers encounter.

REORGANIZATION of the Los Angeles, Calif., County Flood Control District, is announced by C. H. Howell, chief engineer, bringing the two geographical divisions of the district, mountain and valley, together under direct control of the chief engineer. The plan has been approved by the County Board of Supervisors. On recommendation, the board approved the appointment of Samuel M. Fisher as designer of flood control construction. Mr. Fisher formerly was chief engineer of the district, and more recently was chief dam designer. This position recently was abolished.

Resettlement Administration Starts Land Use Program

With an initial allotment of $15,000,000 from work relief funds, the Resettlement Administration has embarked on its land development program. Work will be started in 125 locations to overcome the effects of drought and soil erosion and to promote more beneficial use of land. More than 8,000 men have gone to work and it is expected that the daily average will increase to 75,000 men between now and July 1, 1936. About 5,500,000 acres will be converted into forests, recreation areas, grazing districts and wild life refuges. Land selected for the program is being purchased in areas where the misuse of land has been most severe. The total allocation made by President Roosevelt for this phase of the Resettlement Administration's work is $40,000,000.

Much of the land on which development work is now commencing, according to L. C. Gray, director of land utilization, is being farmed although it is physically and economically unsuited to that use.

World Power Conference Plan Begins to Take Form

Organization and program committees for the World Power Conference to be held in Washington in 1936 were appointed at the first meeting of the executive committee of the Washington Conference held in Washington Nov. 19. Seven principal topics of discussion were approved and were subdivided into 18 specific questions under the general head of "The National Power Economy." Each nation participating will submit one paper on each question, except that on questions of controversial nature two papers presenting the opposite sides may be submitted. Proceedings will be conducted in four languages, French, German, Spanish and English.

Of special interest to the civil engineering field are the following items on the program: Section 4, national planning for most efficient utilization of natural resources; Section 5, problems in regional planning; and Section 7, national power and resources policies.

SOCIETY CALENDAR

HIGHWAY RESEARCH BOARD, annual meeting, Washington, D. C., December 5-6.

AMERICAN ASSOCIATION OF STATE HIGHWAY OFFICIALS, annual convention, Miami, Fla., December 9-12.

AMERICAN SOCIETY OF PLANNING OFFICIALS, state planning conference, Chicago, Ill., December 12-13.

NATIONAL RIVERS & HARBORS CONGRESS, special meeting, New Orleans, La., December 13-14.

NATIONAL ASSOCIATION OF HOUSING OFFICIALS, annual meeting, New York, December 14.

AMERICAN ENGINEERING COUNCIL, annual meeting and conference of Secretaries of Engineering Societies, Washington, D. C., January 9-11, 1936.

ASSOCIATED GENERAL CONTRACTORS OF AMERICA, annual meeting, Miami, Fla., January 13-15, 1936.

AMERICAN ROAD BUILDERS' ASSOCIATION, annual convention and road show, Cleveland, Ohio, January 20-24, 1936.

CONSTRUCTION EQUIPMENT ASSOCIATION, first annual meeting, Cleveland, Ohio, January 20-24, 1936.

NATIONAL PAVING BRICK ASSOCIATION, annual meeting, Columbus, Ohio, January 29-31, 1936.

ASSOCIATION OF HIGHWAY OFFICIALS OF NORTH ATLANTIC STATES, annual meeting, Atlantic City, N. J., February 12-14, 1936.

SOUTHWEST ROAD SHOW AND SCHOOL, Wichita, Kan., February 25-28, 1936.

AMERICAN SOCIETY FOR TESTING MATERIALS, regional meeting, Pittsburgh, Pa., March 4, 1936.

NEW YORK STATE HIGHWAY CHAPTER, Associated General Contractors of America, tenth annual convention, Albany, N. Y., December 4-5.

WESTCHESTER COUNTY CHAPTER, New York State Society of Professional Engineers, special meeting on county water supply, County Center, White Plains, N. Y., December 6.

WASHINGTON IRRIGATION INSTITUTE, annual meeting, Wenatchee, Wash., December 12-13.

NEW YORK SECTION, AMERICAN WATER WORKS ASSOCIATION, midwinter meeting, New York City, December 27.

EXAMINATIONS for registration of professional engineers will be held in the near future as follows:

IOWA—Examiners for registration by the Iowa State Board of Engineering Examiners will be held at the State House, Des Moines, Iowa, December 3-5, 1935.

MICHIGAN—Examinations for registration of Architects, Engineers, and Land Surveyors by the Michigan State Board of Examiners for the Registration of Architects, Engineers and Surveyors will be held December 26-28, 1935. Examinations for architects at the University of Michigan; for engineers and surveyors at University of Michigan, Michigan State College and Ironwood.

Personals

W. W. BESSELL, JR., acting engineer of the Dover area, Muskingum Conservancy District, has been promoted to the rank of captain.

GEORGE W. CALLAHAN, Waterbury, Conn., has been appointed director of projects and planning of the Connecticut WPA, to succeed M. M. MOORE, who was temporarily in charge of this work. Mr. Moore resumes his position as assistant regional engineer.

JOHN F. STEVENS, one time chief engineer of the Panama Canal, well known for railroad location work in the Northwest and the author of a number of engineering articles, was made an honorary member of the Western Society of Civil Engineers at a joint meeting held by that society and the American Society of Civil Engineers Nov. 18, in Chicago.

HENRY D. ABBOTT, formerly an associate of Vaughan Engineers, Boston, Mass., has joined the engineering staff of the bureau of soil erosion, U. S. Department of Agriculture, Washington, D. C.

J. FREDERICK JACKSON, consulting engineer in the Hartford, Conn., office of the PWA, has been appointed acting PWA engineer for Connecticut and Rhode Island, succeeding L. A. HOFFMAN. JOHN G. SILLENBACK, New York, engineer-examiner of the Connecticut PWA staff, has been placed in charge of operations in Rhode Island.

CHARLES M. UPHAM, Engineer-Director of the American Road Builders' Association, has been appointed consulting engineer to the Maryland State Roads Commission. Mr. Upham will continue as Engineer-Director of the A.R.B.A. with headquarters in Washington.

WILLIAM F. DURAND was awarded, by the John Fritz Medal Board of Award, the gold medal for 1936 for notable achievement in hydrodynamic and aerodynamic science, in its practical application, and in engineering education. This award was made unanimously by a board having for its members sixteen past presidents of the four American societies of civil, mining and metallurgical, mechanical, and electrical engineers. Doctor Durand is professor emeritus of mechanical engineering at Stanford University.

THEODORE B. PARKER, director of the PWA in Massachusetts since June, 1934, has been appointed supervising construction engineer for the Tennessee Valley Authority, with offices at Knoxville. Mr. Parker is a graduate of the Massachusetts Institute of Technology, and for eleven years was principal hydraulic engineer for the Stone & Webster Engineering Corp., Boston. During the world war he commanded the 26th Engineers. He has been succeeded at Boston by STEPHEN H. SMITH, chief project examiner of the PWA for the past year. Mr. Smith has also served in the hydraulic engineering division of the Stone & Webster organization. Mr. Parker assumed his new duties on Nov. 15.

Obituary

FAYETTE F. FORBES, for 60 years superintendent of the Brookline, Mass., water department, died at his home in that town on Nov. 20. He was 84 years old. According to a report of the International City Managers Association, Mr. Forbes held the longest record of public service of any man in about 1,000 municipalities of this country.

JOHN F. BRANAGAN, 44, engineer and writer on technical subjects, died at his home in Buffalo, N. Y., Nov. 14. He received his education at Georgetown University and graduated as a civil engineer from Cornell University.

J. A. MACDOUGALL, civil engineer, MacDougall's, N. B., died at his home there recently at the age of 77. During his 50 years of engineering practice he had been in charge of the construction of a section of the Canadian National Ry. for three years and for twelve years he was deputy land surveyor of New Brunswick province.

EDWARD L. WENZ, WPA engineer for Lucas and Wood counties, Ohio, died Nov. 4 in Perrysburg,, after having been struck by an automobile. Mr. Wenz was 50 years old at the time of his death.

E. E. BONEWITS, 45, died recently in Milwaukee, Wis. Mr. Bonewits, at the time of his death, was engineer and consulting representative of the Portland Cement Association, and was appointed some time ago by Mayor R. E. Overman, Little Rock, Ark., to work with the consulting engineers in preparation of the plans and specifications for the proposed reservoir. For four years, 1923 to 1927, he was a district highway engineer for the Arkansas State Highway Department.

HARRY L. SHANER, commissioner of public works, Winston-Salem, N. C., died at his home there, Nov. 20. He was 56 years of age. Mr. Shaner graduated in civil engineering from Virginia Military Institute in 1899. In the same year he became assistant city engineer of Lynchburg, Va. He continued in this position until 1904 when he was made city engineer, a position he held until 1918 when he went to Winston-Salem and took up his duties as commissioner of public works.

FRANK W. FLITTNER, associate construction engineer, U. S. Bureau of Public Roads, died Oct. 26, at Phoenix, Ariz. He was 42 years old. He graduated from the University of San Francisco in 1916, and after graduation worked with the Shell Oil Co. for a time, and then entered the Army in 1917 as lieutenant, in the Engineer Corps. In 1929 and 1930 he was engaged in private practice on various surveying and estimating projects. He entered the Bureau of Public Roads in 1931, as associate construction engineer assigned as supervising engineer in Southern Arizona and Southeastern California.

IRVING PATTERSON KANE, engineer of treatment plant design, Sanitary District of Chicago, died in that city Nov. 20. Born in 1886 in Baltimore, Md., Mr. Kane was graduated in sanitary engineering from the Massachusetts Institute of Technology in 1910 and for three years was assistant engineer with the Baltimore Sewerage Commission. Then for a year he was with International Joint Commissioner as assistant engineer at Detroit in connection with pollution of boundary waters. With the Sanitary District of Chicago, since 1919, he has been engaged continuously on treatment plant design and was active in developing a sludge stripping machine. He had a large part in the design of the Calumet, West Side and North Side works.

HENRY VIER died at his home in White Plains, N. Y., on Nov. 18, at the age of 71. Mr. Vier retired from active service as chief engineer in the land tax department of the New York Central Railroad three years ago. He graduated in civil engineering from Rensselaer Polytechnic Institute in 1883. He then spent five years as draftsman in the Watervliet Arsenal, West Troy, N. Y., and then, after working as assistant engineer on the extension of the Lansingburg waterworks, went with the New York Central & Hudson River R.R., and from 1895 to 1898 was assistant engineer in charge of the Buffalo grade crossing im-

provement. In 1898 he became assistant engineer in charge of resurveys and subsequently became chief engineer in the land tax department.

WALTER BUTLER HARRIS, professor emeritus, engineering faculty, Princeton University, died at his home in Princeton, N. J., on Nov. 21 at the age of 70. Professor Harris received his engineering degree from Princeton University in 1886 and then spent three years with railroads and coal companies, returning to Princeton as instructor in civil engineering and shortly after was promoted to assistant professor. He was later made professor of geodesy and was responsible for the development of that department. He remained in this position until his retirement in 1934, after which he served as a special lecturer in the school of engineering. Professor Harris devoted a good deal of attention to the development of jetties and some of the developments which he fostered were later put into effect along the New Jersey shore. He also designed a number of buildings in Princeton, and he also developed the plans for Wilson College, Chambersburg, Pa.

CONSTRUCTION STATISTICS FOR THE WEEK

ENGINEERING awards for the short week due to Thanksgiving Day total $41,863,000 compared with an average volume per week to date of $28,222,000 and an average volume per week for last year of $26,165,000. Heavy volume of state and municipal awards and higher private awards are responsible for the sustained high rate of putting work under contract.

This week's volume is made up of private awards, $7,772,000; public, $34,091,000, of which $3,662,000 is federal and $30,429,000 is state and municipal. Comparable figures a year ago are: total, $16,224,000; private, $3,610,000; public, $12,614,000; federal, $2,456,000 and state and municipal, $10,158,000.

In spite of the four-day week this week compared with the five-day week last week bridge awards, industrial buildings and public buildings are higher, other classifications are below the high volume reported a week ago. The values are: commercial buildings, $2,985,000; industrial buildings, $3,166,000; public buildings, $6,820,000; streets and roads, $11,014,000; bridges, $4,658,000; waterworks, $813,000; sewerage, $7,704,000; earthwork, irrigation and waterways, $2,554,000.

The larger contracts for the week include: Rack house for Hiram Walker & Sons, Peoria, Ill., $450,000; rebuilding machine shop and plant consolidation for Youngstown Sheet & Tube Co., Youngstown, Ohio, $1,000,000; apartments for John D. Rockefeller, Jr., West 54th and 55th Sts., New York City, $1,600,000; Glen Dale sanitarium at Buena Vista, Md., for District Commissioners, Washington, D. C., $882,000; school, Rhode Island School of Design, Providence, R. I., $700,000; high school, Newburyport, Mass., $474,000; post office, Vicksburg, Miss., $446,000; students' building, University of Cincinnati, Cincinnati, Ohio, $554,000; highway awards by Oregon, $876,000; by Nebraska, $617,000; by Pennsylvania, $600,000; by Texas, $1,091,000; by Kansas, $1,527,000; filling in Sanhican Creek to make boulevard, Trenton, N. J., $550,000; bridges by Oregon, $443,000 and by Texas, $540,000.

Sewerage awards include Sections C, D, E, sludge line between easterly and southerly sewage plants, Cleveland, Ohio, $310,000; Abeyona Valley Sewer line, WPA labor, Woburn, Mass., $3,000,000; sewage treatment works, Contracts 11 and 12 B, Wards Island, New York City, $2,358,000. Other large awards include two hydraulic turbines and two governors, Bureau of Reclamation, Boulder City, Nev., $584,000; hurricane gates and drainage structures, Okeechobee City, Fla., $518,000; altering Emsworth Dam, Pa., $877,000 and 15,000 tons steel rails for Northern Pacific R.R., St. Paul, Minn., $500,000.

State and municipal bonds sales for the week are $9,936,000.

CONTRACTS

(Thousands of Dollars)

	Weekly Nov. 1934	Average Week Prev.4 Weeks	Nov.28 1935
Federal Government	$6,333	$3,944	$3,662
State and municipal	16,724	25,092	30,429
Total public	$23,057	$29,036	$34,091
Total private	3,826	6,324	7,772
Week's total	$26,883	$35,360	$41,863

Cumulative to date:
1934..$1,259,477,000 1935..$1,354,645,000

NEW PRODUCTIVE CAPITAL

(Thousands of Dollars)

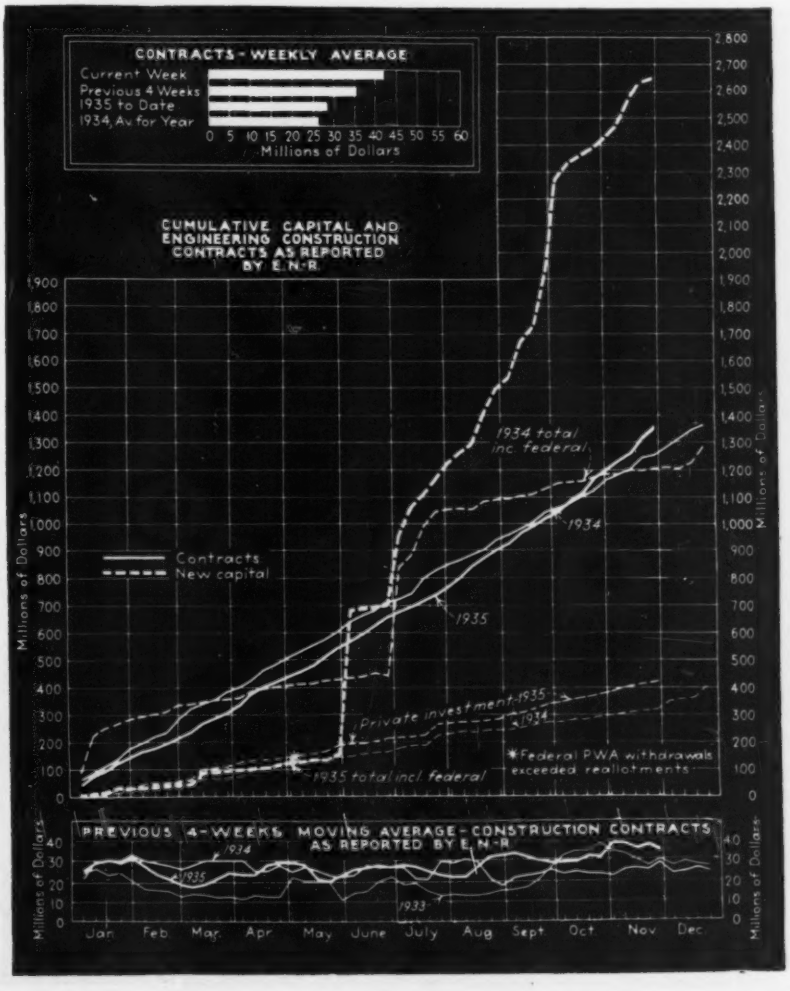
1935	Week Nov.28	Cumulative
State and municipal	$9,936	$393,106
PWA allotments, S&M.	1,750	787,919
RFC loans, S&M	.....	48,180
Corporate issues	.....	27,738
PWA private	.....	9,086
Local contrib. to WPA.	.....	31,861
Total non-federal	$11,686	$1,297,890
PWA federal	1,410	1,348,037
Total new capital	$13,096	$2,645,927

Cumulative to date:
1934..$1,204,033,000 1935..$2,645,927,000

Note: These figures include private bonds, and stocks sold for productive purposes; state and municipal bonds for construction; PWA loans and grants to states and municipalities, including the special highway funds; PWA private loans, and allotments for federal construction, deficiency act funds. An arbitrary percentage (25%) of the WPA allotments and local contributions to WPA work is included to allow for the capital additions through the Works Progress Administration division of the new program.

INDEX NUMBER

ENR Cost	1913 = 100	1926 = 100	ENR Volume	1913 = 100	1926 = 100
Nov., 1935	184.90	93.69	Oct., 1935	162	71
Oct., 1935	195.10	93.82	Sept., 1935	127	56
Nov., 1934	201.36	96.76	Oct., 1934	101	44
1934 (Av.)	198.10	95.23	1934 (Av.)	114	50
1933 (Av.)	170.18	81.80	1933 (Av.)	102	47
1932 (Av.)	156.97	75.45	1932 (Av.)	127	56


CONTRACTS - WEEKLY AVERAGE
Current Week
Previous 4 Weeks
1935 to Date
1934, Av for Year
0 5 10 15 20 25 30 35 40 45 50 55 60
Millions of Dollars
CUMULATIVE CAPITAL AND ENGINEERING CONSTRUCTION CONTRACTS AS REPORTED BY E.N.-R.
Millions of Dollars
Contracts
New capital
1934 total inc. federal
1934
1935
Private investment-1935
1934
1935 total incl. federal
*Federal PWA withdrawals exceeded reallotments
PREVIOUS 4-WEEKS MOVING AVERAGE - CONSTRUCTION CONTRACTS AS REPORTED BY E.N.-R.
1934
1935
1933
Jan Feb Mar Apr May June July Aug Sept Oct Nov Dec

Construction Equipment and Materials

Bethlehem Introduces Kalman Road Joints

Two types of transverse expansion joints, air cushion and elastic cushion, and a contraction joint of similar design have been developed by the Kalman Steel Corp., subsidiary of Bethlehem Steel Corp., Bethlehem, Pa.

These Kalman Road Joints are shop-assembled interlock units that come to the job complete, requiring only to be set in place on the subgrade and staked to prevent movement while concreting. Their design embodies a distinctive system of interlocking lugs and recesses formed directly in the concrete, so proportioned and spaced that the strength of the concrete is utilized to its best advantage. Bottom, top and ends are arranged to prevent entry of foreign materials into the body of the joint.

In the air-cushion type there is a ⅜-in. air space, transversely in the joint, while in the elastic-cushion type specified material such as cork, rubber or other approved expansion joint material is mounted on steel surfaces. The detail of the contraction joint embodies all the features of the Kalman Interlock Joint, but with the expansion provision omitted.

Light-Weight Plows Aid In Quick Snow Removal

The practicability of snow fighting on highways by using lighter snow plows mounted on lighter truck equipment is shown in the accompanying photograph, which pictures a plow of the Good Roads Machinery Corp., Kennett Square, Pa., on a Ford dump truck.

Plows of different types ranging in weight from 925 lb. to 1200 lb. may be mounted on the truck in such a way that no change in the design of the frame or other truck parts is necessary. An underframe method of attachment is used, effecting an even distribution of the thrust load over the truck structure in such a way that no part is subjected to undue strain.

The plow shown here weighs 1100 lb. Other light plow models are of the reversible-blade type.

High-Speed Non-Clogging Pump For Handling Sewage

A non-clogging pump for handling sewage or pulpy materials at high speeds and against high heads has been developed by Morris Machine Works, Baldwinsville, N. Y. This new design permits the use of standard high-speed motors.

The unit is completely self-contained, with heavy-duty double-ball radial and

thrust bearings supported on a substantial extension of the hub disk so that both bearings are maintained in perfect alignment with the pump body. The impeller of each size will pass solids up to 1 in. smaller size than the pump outlet. Efficiencies above 85 per cent have been obtained in several installations. The new units are built both vertical and horizontal, in sizes from 3 to 10 in., with open or enclosed impellers.

New Equipment in Brief

Cloroben: A new product for the reduction of odors and prevention of septicity in sewage will be marketed by the Seydel Chemical Co., Jersey City, N. J., with the formation of the Cloroben Corp. on or about Dec. 5. A number of experimental studies have indicated the applicability of chlorinated hydrocarbons, for the control of bacterial life, to various problems in sanitary engineering. In the field of sewage disposal it is claimed to be effective as inhibitory to the formation of hydrogen sulphide, and it assists in weighing down floating scum and sludge layers. Sprinkled on refuse heaps, it decreases their objectionable odors and discourages the dissemination of communicable diseases by flies; its use in septic tanks, latrines and polluted ponds aids in the abatement of nuisances.

Business Notes

WORTHINGTON PUMP AND MACHINERY CORP. is building an additional machine shop building at its Buffalo, N. Y., plant. This extension will have a floor area of 75,000 sq.ft.

WILLIAM J. REARDON of the Reardon Cement Co., Cincinnati, Ohio, has been appointed to the Ohio River Stream Pollution Committee of the Cincinnati Chamber of Commerce.

THE LIDGERWOOD MANUFACTURING CO., Elizabeth, N. J., has acquired the J. S. Mundy Hoisting Engine Co., Newark, N. J. The Mundy Company, under its original name, will continue the manufacture of the Mundy line of hoisting equipment, as well as the servicing of Mundy machinery now in the field.

BOSTON WOVEN HOSE & RUBBER CO., Cambridge, Mass., has appointed W. A. Briggs as Southern District sales manager with headquarters at Atlanta, Ga.

New Publications

NON-CLOGGING SEWAGE AND SLUDGE PUMPS, Lawrence Machine & Pump Corp., Lawrence, Mass. 8½x11, 4 pages. Bulletin 206.

SYNTHANE LAMINATED BAKELITE FOR MECHANICAL APPLICATIONS, Synthane Corp., Oaks, Pa. 4x9, 6 pages.

STEEL BEARING PILES, Carnegie Steel Co., Pittsburgh, Pa. 8½x11, 78 pages.

CONDOR COMPENSATED BELT, Manhattan Rubber Mfg. Division, Passaic, N. J. 8½x11, 4 pages.

G. & R. SELF-PRIMING AND SELF-CLEANING PUMPS, Gorman-Rupp Co., Mansfield, Ohio. 8½x11, 5 pages.

SMITH NON-TILT MIXERS, 7-S and 10-S, T. L. Smith Co., Milwaukee, Wis. 8½x11, 8 pages.

TEXROPE DRIVES, Allis-Chalmers Mfg. Co., Milwaukee, Wis. 8½x11, 32 pages. Bulletin No. 1259.

TERM-PAYMENT PLAN FOR MODERNIZING INDUSTRIAL PLANTS UNDER THE NATIONAL HOUSING ACT, Worthington Pump & Machinery Corp., Harrison, N. J. 8½x11, 4 pages.

TEN WAYS OF GETTING MORE WORK OUT OF MOTOR TRUCKS, The Service Recorder Co., Cleveland, Ohio. 6x9, 12 pages.

FACTS ABOUT BUILT-UP ROOFS, Johns-Manville, New York City. 8½x11, 22 pages.

CARBONDALE BRINE COOLERS, Carbondale Machine Corp., Harrison, N. J., 8½x11, 8 pages. Bulletin 1103.

ALL WELDED JOINTLESS POST GUARD RAIL, Fabricated Steel Products Co., Wheeling, W. Va. 8½x11, 10 pages.

AIR CUSHION VALVE VACUUM PUMPS, Pennsylvania Pump & Compressor Corp., Easton, Pa. 8½x11, 12 pages.

CARBON MONOXIDE INDICATOR, Mine Safety Appliances Co., Pittsburgh, Pa. 8½x11, 4 pages.

GOETZE GASKETS, Goetze Gasket & Packing Co., New Brunswick, N. J. 8½x11, 64 pages.

COMBINED ENGINE & COMPRESSOR, Cooper-Bessemer Corp., Grove City, Pa. 8½x11, 4 pages.

UNION PILE HAMMER, Union Iron Works, Inc., Elizabeth, N. J. 8½x11, 12 pages.

OVER THE ROUGH SPOTS, Stonhard Co., Philadelphia, Pa. 5½x8½, 25 pages. Building maintenance material.

BROWN AIR OPERATED CONTROLLERS, Brown Instrument Co., Philadelphia, Pa. 8½x11, 24 pages. Catalog No. 8900.